AN ASSESSMENT OF THE IMPACT OF *KILIMO PLUS* SUBSIDY PROGRAM ON SMALLHOLDER FARMERS' FOOD SECURITY AND INCOME IN NAKURU NORTH DISTRICT, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfilment for the Requirement of the Award of the Degree of Master of Science in Agricultural and Applied Economics of Egerton University

EGERTON UNIVERSITY

MAY 2014

DECLARATION AND APPROVAL

Declaration

I declare that this is my original work and has not been presented wholly or in part for any award in this or any other institution of learning.

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Recommendation

This thesis has been submitted with our approval as candidates' supervisors.

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DEDICATION

I dedicate this thesis to our parents Eutychus Kiratu Mwangi and Peninnah Nyambura Kiratu.

ACKNOWLEDGEMENT

First and foremost, I wish to thank the Almighty God for giving me strength, good health and courage throughout the study period. I am also grateful to the Government of Kenya and the African Economic Research Consortium (AERC) for funding my research, and sponsoring my studies at the shared facility at the University of Pretoria**.** My heartfelt gratitude goes to my supervisors: Prof. Margaret Ngigi and Prof. Patience Mshenga for spending their precious time in guiding, advising and encouraging me from the inception to the end of this thesis writing. Their constant guidance and comments were of great importance in making this work a success. I am thankful for their kindness, patience and understanding. Thanks to the Department of Agricultural Economics and Business Management, for providing a favourable learning environment. Thanks to my family (Eutychus Kiratu Mwangi, Peninnah Nyambura Kiratu, Nicholas Kuria Kiratu and Gideon Nguhiu Kiratu and Tabitha Kavuli Itotia) for their support, prayers and love throughout the study period. Many thanks to Mrs. Judith Wandahwa and the agricultural officers in Nakuru North district for their help in data collection. I also appreciate all my course mates, friends, enumerators and farmers who contributed to the success of this thesis.

ABSTRACT

Poverty and food insecurity still plague the world today despite an effort by world leaders to address these two major problems through initiatives such as the Millennium Development Goals. Majority of the world's population who suffer from poverty and food insecurity live in rural areas and rely on agriculture and agricultural related activities for their livelihood. Increasing productivity has been cited as a way of increasing farmers' incomes and reducing their food insecurity at the household level. Stakeholders have thus advocated for the use of subsidies through such programs as *Kilimo Plus* in an attempt to provide the farmers with the essential inputs that are necessary to increase production. The program aims to increase smallholders' productivity by providing fertilizer and certified seeds. This study sought to determine the perception of farmers towards this program, the factors that influence the farmers' perception towards the program and the program's impact on food security and incomes of the smallholder farmers' households. A sample of 400 smallholder households, comprising of both the beneficiaries and non-beneficiaries of the *Kilimo Plus* program were selected. Data was collected with the aid of a semi-structured questionnaire. The first objective was analysed using descriptive statistics, the second objective using an ordered probit model and the third and fourth objectives using propensity score matching technique. The descriptive analysis showed that the farmers' perception of the *Kilimo Plus* program was good. The ordered probit regression results showed that the factors that significantly influenced the farmers perception were the gender of the household head, farm size, being in the *Kilimo Plus* program, being the household head, having an incomplete primary school education and learning of the *Kilimo Plus* program through a friend or neighbour, farmer group or radio, production increase and training on farming and inputs use. The propensity score matching model analysis showed that the program had a positive impact on food security and income. The government should however aim at improving the program by giving the right kind of inputs to the farmers and at the right time. Furthermore, the program should be extended in order to have a long-term impact on the smallholder farmers' food security and income.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADC	Agricultural Development Corporation
AGMARK	Agricultural Market Development Trust
AGRA	Alliance for a Green Revolution in Africa
ATCs	Agricultural Training Colleges
AU	African Union
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Databases
FIPS	Farm Input Promotion Africa
IFDC	International Fertilizer Development Centre
KAPAP	Kenya Agricultural Productivity and Agribusiness Project
KARI	Kenya Agricultural Research Institute
KFA	Kenya Farmers Association
KSC	Kenya Seed Company
KShs	Kenya Shillings
MDG	Millennium Development Goal
MDG	Millennium Development Goals
MoA	Ministry of Agriculture
NAAIAP	National Accelerated Agricultural Inputs Access Program.
NCPB	National Cereal and Produce Board
NGO	Non-Governmental Organization

OECD	Organisation for Economic Co-operation and Development
SCODP	Sustainable Community-Oriented Development Program
SSA	Sub Saharan Africa
UN	United Nations

CHAPTER ONE
INTRODUCTION

1.1. Background Information

Post-colonial Sub-Saharan Africa has experienced high population growth. This, coupled with industrial growth that is demanding more raw materials from agriculture, has led to increased pressure on food security in the region. Furthermore, although a majority of the population lives in the rural areas with agriculture being their main source of livelihood, agricultural productivity has declined over the years. Consequently over seventy percent of the population lives below the poverty line with the region having the highest rates of undernourished people in the world (FAO, 2010).

To overcome the challenges, many Sub-Saharan African governments as well as development partners have been looking for strategies of ensuring food security. The efforts range from revising policies, implementing countrywide universal fertilizer subsidies and reducing government involvement in the fertilizer industry. These strategies are geared towards increasing agricultural production especially production of staple foods like maize through agricultural intensification. Intensification in agriculture has also been necessitated by loss of arable land due to soil mining. This has led to the region being branded a land scarce region (Binswanger and Pingali, 1988). The loss of nutrients in the soil can be attributed to low fertilizer use since Sub-Saharan Africa (SSA) farmers used about 13 kilograms of fertilizer nutrient per hectare in 2005 and projected to increase to 27 kilograms per hectare by 2050 in comparison with the developing countries average of 144 kilograms per hectare in 2005 and a projected 166 kilograms per hectare by 2050 (Alexandratos and Bruinsma, 2012).

The low use of fertilizer per hectare is partly attributed to the challenges farmers in the region face in their capacity to access fertilizer. The first challenge is physical access to fertilizer. Fertilizer access is hindered by poor infrastructure in the region. This coupled with a heavy government involvement in the importation and distribution of fertilizer constrains private sector investment. Additionally, access to fertilizer is hindered by political interference. Politicians use the fertilizer subsidy program as a tool of seeking for votes. The politicians accomplish this by using fertilizer procurement and distribution channels as opportunities for rent seeking where business persons allied to them get the tenders and in return they fund the politicians' political

ambitions. This leads to fraudulent behaviour that denies the targeted beneficiaries from accessing fertilizer (Dorward and Chirwa, 2011). Another factor that limits fertilizer access is inadequate access of credit by farmers. Farmers, especially in rural areas have a seasonal demand for credit where their bank deposits and borrowing reflects a pattern tied to agricultural cycle. This pattern constrains banking sector development due to the irregular and inadequate demand of credit by farmers. Inadequate banking sector development leads to low fertilizer market development since agro-dealers are unable to access the credit necessary for investment in the rural areas necessitating farmers to cover long distances to access fertilizer (Dorward, 2009; Duflo *et al.*, 2009).

These challenges contribute to farmers in SSA applying less fertilizer per hectare than is economically optimal (Yanggen *et al*., 1998). One of the reason farmers apply less fertilizer per hectare is lack of information on how to use fertilizer effectively. Farmers being risk averse and unwilling to invest in fertilizer use due to unpredictable weather also makes the SSA farmers to use a lower rate of fertilizer per acre. In addition, having inadequate money to pay for the fertilizer because of the low income and poorly functioning credit market also leads to a low fertilizer application rate (Minot and Benson 2009).Increasing the fertilizer application rates among SSA farmers is seen as a solution to the low productivity in the region especially after a high fertilizer application rates resulted in increased production in the Green Revolution in Asia.

Despite the well-known successes of fertilizer subsidies in the Green Revolution in Asia, fertilizer subsidies in Africa still remain a controversial issue. Proponents of fertilizer subsidies point to the need to boost agricultural productivity among resource poor farmers through fertilizer subsidies in the face of a growing population and a decreasing supply of agricultural land (Henao and Baanante, 1999). They also argue that subsidies represent transfers to the poor and it is more efficient than other anti-poverty programs like school feeding programs and conditional cash transfer. Opponents of fertilizer subsidies, on the other hand, base their arguments on the 1970s and 1980s failure of subsidy programs due to high operational costs and its limited effectiveness (Dorward *et al.*, 2008).However the use of fertilizer subsidies in Africa seems to be unavoidable especially because of the low productivity being evidenced in the continent.

Proponents of fertilizer subsidies are now advocating for smart subsidies which are "mechanisms to provide subsidized goods and services designed both to promote market

development and to enhance welfare of the poor" (Minot and Benson, 2009). Smart subsidies are often administered to the poor farmers through a voucher system. The National Accelerated Agricultural Inputs Access Program (NAAIAP) is a Kenyan government voucher–based subsidy program that targets the resource poor farmers. The program is also geared towards market development by partnering with the private sector especially agro-dealers. It is a smart subsidy that the government of Kenya implemented to increase the income and food security of poor smallholder farmers.

1.2 NAAIAP Program

The National Accelerated Agricultural Inputs Access Program (NAAIAP) was started by the Kenyan government in 2007 with the government as the sole funding agency, but now funding incorporates both the private sector and development partners. The program was designed to act as a safety net for poor farmers who did not have adequate resources. The program was geared towards addressing the Millennium Development Goal 1(MDG 1) of halving the extreme poor and hungry by 2015 (UN, 2000). It was the governments' response to the 2001 Fertilizer conference in Nigeria that came up with the "Abuja Declaration on Fertilizer for the African Green Revolution". This Declaration recognized nutrient depletion in African soils due to nutrient mining either without replacement or inadequate replacement. This has led to low productivity and an incapacitation of the farmer to meet neither their own food requirement nor the growing population food need (AU, 2006).

The objective of the program is "To increase agricultural productivity for farmers with less than one hectare of land through provision of basic farm inputs; and mobilization of farmers' resources for re-investment in agriculture" (MoA, 2010). The program covered 150 districts in the country by the year 2012. The program has four components (MoA, 2010) which are *Kilimo Plus*, *Kilimo Biashara*, orphan crop promotion and agro-dealer network development.

1.2.1. *Kilimo Plus*

Kilimo Plus, targets resource poor farmers who own less than a hectare of land. The farmers are given a *Kilimo Plus* Starter kit comprising of 10 kg of certified maize seed, 50kg of base fertilizer, and 50kg of top dressing fertilizer and must also attend training. The kit is supposed to aid the farmers to cultivate at least 0.4 hectares of land which is enough to provide

enough food for an average household (five persons) at an annual per capita maize consumption of 98 kg (FAOSTAT, 2013).

The grant is administered through a voucher issued to the farmer. The voucher enables him/her to purchase inputs from accredited stockists who have undergone training. The stockists redeem the voucher from a government contracted financial provider. A stakeholder forum vets grants beneficiaries, authorize grants and approves vouchers. The beneficiary farmer receives the *Kilimo Plus* Starter kit for two seasons. Part of the produce (approximately 30%), is put in a farmer's group cereal bank in order to finance the farmer group's subsequent inputs. After two seasons, the farmers are expected to graduate to the next category of *Kilimo Biashara*.

1.3 Statement of the Problem

Addressing poverty and food insecurity among smallholder farmers in Kenya has become a paramount issue in a country where land holding is small with approximately 3.5 million farmers in Kenya owning one hectare of land or less. Even though smallholder farmers produce 75% of livestock, food crop and cash crop in the country, most of them practice traditional farming methods that do not use fertilizer or use low amounts of fertilizer than economically optimal and uncertified seeds (MoA, 2010). This has necessitated the government of Kenya to come up with programs such as *Kilimo Plus* subsidy Program that can increase production as a way of addressing food insecurity and low incomes among smallholder farmers.

However, unless this intervention is evaluated on their effectiveness on the targeted smallholder farmers, the achievement of the programs' goals remains obscured by the assumption that the interventions have solved the problem of food insecurity and low incomes. The programs also utilise funds from the public hence the need for the government to be accountable in the use of the funds.

1.4 Objectives

1.4.1 General Objective

The main objective of this study was to contribute to food security and income of smallholder farmers by generating knowledge on how smart subsidies address equity problems.

1.4.2 Specific Objectives

1. To determine the perception of the smallholder farmers towards the *Kilimo Plus* program.
2. To determine the factors influencing smallholder farmers perception of *Kilimo Plus* program.
3. To determine the impact of the *Kilimo Plus* program on food security of smallholder farmers households.
4. To determine the impact of the *Kilimo Plus* on the income of smallholder farmers.

1.5 Research Questions

1. What is the perception of smallholder farmers towards *Kilimo Plus* program?
2. What factors influence the perception of smallholder farmers towards the *Kilimo Plus* program?
3. What is the impact of *Kilimo Plus* program on the food security of smallholders?
4. What is the impact of *Kilimo Plus* program on the income of the smallholder farmers?

1.6 Justification of the Study

The global economy and agricultural sector budgets have become stretched out by the increase in demand for funds and scarce sources of the funds. The 2007/2008 global financial, food and energy crisis showed that the world has entered into a new energy food price regime, with the donor countries and agencies suspending or cutting on donor funding due to the crisis. Since the *Kilimo Plus* program is partly funded by the donor community, there is need to justify why the program should be allocated funds. Furthermore, there is a need to account for the funds utilized by the government in research, policy making and implementation. For example, the government spent 637 billion shillings in the 2009/2010 financial year and 681 billion shillings in the 2010/2011 financial year to finance the NAAIAP program (MoA, 2009, MoA, 2010). The *Kilimo Plus* subsidy program is a component of the NAAIAP program which provides inputs such as fertilizer and seeds to resource poor farmers in the rural areas. Given that part of the funds is sourced from taxes, they should be used in the most effective and efficient way to

benefit the population. Since the government has invested a lot of money in this program as a way of improving livelihoods, it is important to evaluate its contribution to improving smallholder income and food security. This study aimed at providing the evidence of whether the *Kilimo Plus* program is benefiting the targeted population.

In addition, research based policy making has been shown to be more effective and successful in its implementation. In order to have good policies in the future necessitates investing in research. Thus as the world is moving towards evidence-based policy making, there is a need to verify the results of such interventions as *Kilimo Plus* by substantiating the outcomes and results brought about by the intervention and therefore the purpose of this study.

However, unless there is evaluation based on the impacts that these subsidies have on the smallholder farmers, the subsidy programs prove to be ineffective since the target population is not being reached.

1.7 Scope and Limitation of the Study

The study covered Nakuru North District in Nakuru County. The study involved the farmers in the district who benefited from the *Kilimo Plus* subsidy program who formed the participant group and farmers who were not in the program who were the non-participant group. The study determines the perception of the smallholder farmers towards the program and what influences their perception. Furthermore, the study determines the impact that the *Kilimo Plus* program has had on the smallholder farmers' food security and income.

The study is limited to smallholder farmers who produce maize in the district. Thus the study results may not apply to other farmers who grow other types of crops. The information given by the respondents was also dependent on the ability of the respondent to recall. Thus in order to overcome this limitation, information on the implementation of the program was also derived from the Ministry of Agriculture (MoA) publications and agricultural officers in the district.

1.8 Definition of Terms

Smallholder farmer: a farmer who owns not more than 1 hectare.

Input access: ability to obtain inputs within ones means and reasonable distance and procedure.

Household: an independent person and his or her dependants living together and with one person making the decisions.

Food security: Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996).

Agricultural subsidy: sum of money, goods or services from public funds to help the agricultural industry or business keep the price of a commodity or service low and affordable in order to achieve a specific goal.

Household income: monetary value that a household can consume within a specific time while leaving the household with the same stock of goods and assets.

CHAPTER TWO
LITERATURE REVIEW

2.1 Smallholder Farming in Sub-Saharan Africa

Smallholder farms make the larger percentage of SSA agriculture with 80% of the total number of farmers being smallholders. These own land of up to two hectares (Livingston *et al.*, 2011). Despite the small land holdings, smallholders contribute up to 90% of the total agricultural production of some SSA countries (Wiggins, 2009). In spite of this magnanimous contribution of smallholder farms in SSA, intensification in the region still remains low. A study by Henao and Baanante (2006), found out that the farmers in the region have been increasing the land area under production rather than increasing the land productivity. This shows that intensification in SSA has been growing at a low rate compared to other regions in Africa (Wiggins, 2010; FAOSTAT, 2010).

Henao and Baanante (2006) found that from 1961 to 2007, South Asia's cereal production increased with only a 20% increase in land area under production while Sub-Saharan Africa increase in cereal production was due to a 215% increase in land area under production. This resulted in other regions achieving over 80% cereal production from intensification while SSA achieved over 70% increase in cereal production from extensification. But due to the limited land resource, growth in productivity in SSA lies in intensification as opposed to extensification. Intensification includes on-farm investments such as use of certified seeds and fertilizer. Although the limited application of intensified agriculture in SSA can be looked upon as a disadvantage to the region, it also presents an opportunity for the smallholder farmers. This is because the world is now turning to SSA due to the region's under or unutilized resources for future supply of agricultural products and agricultural raw materials (Livingston, 2011).

2.2 Agricultural Subsidies in Africa

Fertilizer subsidies were common in SSA in the 1960s to 1980s. These subsidies were implemented through government owned bodies. Such bodies controlled importation and distribution of the subsidized fertilizer hence leaving out the private sector (Minot, 2009). In Africa, subsidized fertilizer was distributed by the parastatals at a pan-territorial price throughout the countries (Minot and Benson, 2009). According to policy analysts these universal subsidies

had negative results. This was due to such issues as rationing of fertilizer, high cost of implementing the subsidy program, lack of involvement of the private sector, inefficiencies and leakages that benefit the well-off farmers hence undermining the equity argument of subsidies (Morris *et al*., 2007; Minot 2009).

In the wake of the above challenges to the universal subsidies programs, the World Bank and other international donors called for the implementation of the structural adjustment programs. These programs led to removal of universal fertilizer subsidies and liberalization of the fertilizer market in order to support private sector development (Minot, 2009). Research has indicated that the removal of subsidies led to a reduction in fertilizer use and consequently a decrease in production (Banful, 2011).The low production has led to increased food insecurity and high poverty rates especially among the resource poor smallholder farmers. Furthermore, the food, energy, and financial crisis of 2008 has created a renewed interest in subsidies in SSA with even donors who were previously opposed to subsidies now showing interest and even willing to support them (Kelly *et al*., 2011; Druile and Barreiro-Hurle, 2012).

In 2006, the African Fertilizer Summit came up with the 'Abuja Declaration' which emphasized that African Union member states should increase fertilizer use rate, from a rate of 8kg per hectare to an average of 50kg per hectare by 2015. One of the ways of achieving this was to grant targeted fertilizer subsidies (AU, 2006). Similarly, the Alliance for a Green Revolution in Africa (AGRA) has also been vocal in the proposal of use of fertilizer subsidy and certified seeds in increasing production in SSA citing the success of such an initiative in Malawi (Druile and Barreiro-Hurle, 2012).The success of the Malawian subsidy program that was started in 1998 has led to the start of similar programs in Nigeria, Zambia, Tanzania, Kenya and Ghana. This success has also brought a paradigm shift among the donor community.

2.3 Seed and Fertilizer Subsidies in Kenya

Kenya's fertilizer sector has been remarkable in that it is seen as one of the few countries in SSA that has maintained a successful fertilizer reform policy (Freeman and Kaguongo, 2003). The Kenya Farmers Association (KFA) which later became the Kenya Grain Growers Cooperative Union (currently renamed as KFA Limited), was a monopoly in fertilizer imports and distribution for ten years from 1974. KFA being a government body meant a heavy

government involvement in the fertilizer industry, from importing to pricing and marketing. The government used policy instruments such as licensing, quotas, price subsidies and price controls to maintain control of the fertilizer industry (Yamano and Arai, 2010).

The heavy government involvement in the fertilizer trade came under criticism for hindering private sector investment in the fertilizer industry. This led to a review of the government's policies and in the 1980's, the government partly allowed private sector participation but still maintained considerable control (Jayne *et al.*, 2003). Thus, the private sector did not participate fully until after 1993 when the government fully liberalized the fertilizer market. The government also reduced donor fertilizer imports to 5% which made way for the private sector to fully establish itself and led to increase in fertilizer use in the country (Jayne *et al.*, 2003).

This increase in fertilizer usage occurred devoid of government subsidies. After the liberalization of the fertilizer industry and removal of subsidies, the government rolled out a subsidy program a decade later. The subsidy program was in response to an increase in the global fertilizer prices in 2009 when prices rose by 140% for a 50 kilogram bag of calcium ammonium nitrate (CAN). The subsidy was intended to cushion the farmers against the high surge in fertilizer prices. Seeds from the Kenya Seed Company were also subsidized. The body mandated with the distribution of the subsidy was the National Cereal and Produce Board (NCPB) which raised a concern among the private sector stakeholders.

On the other hand, the Non–Governmental Organisations (NGOs) have also played a major role in seed and fertilizer availability in Kenya. One such NGO is the Sustainable Community-Oriented Development Program (SCODP). In 1990, SCODP initiated a program to increase input use by resource poor farmers in the then Nyanza province. The NGO provided small packs of fertilizer and seeds. This initiative was aided by the government, when it repealed the law that prohibited the sale of fertilizer in less than 50 kilograms bag that had been legislated to prevent adulteration of fertilizer. The Farm Input Promotion Africa (FIPS) was an NGO formed in 2003 to facilitate the scaling up of the SCODP programme to high potential areas of Kenya. FIPS also played a major role in the introduction of certified seeds and fertilizer to smallholder farmers, who could not afford to buy them in the standardized measurement. FIPS

also introduced new, drought resistant, disease or pest resistant varieties, use of herbicides and partnership between farmers, public sector and the private sector.

2.4. Impact Assessment Approaches and Application

Any type of evaluation seeks to answer descriptive, normative and cause-and-effect questions (Imas and Rist, 2009). Descriptive questions aims at determining what is happening in relation to relationships among the stakeholder while normative questions aim at finding out the whether the inputs, activities and outputs are being realized. On the other hand, cause-and–effect questions assess whether the outcome is being realized and the difference that these outcomes has on the targeted population. As such, impact assessment seeks to answer a cause-and-effect relationship. Unlike general evaluation that may give answers to many questions, impact evaluation is structured around a particular impact of a program on an outcome of interest (Gertler *et. al.*, 2011). In this study, the outcome of interest was perception, food security and income of the smallholder farmers.

In trying to look at the effect of any outcome on a population, the basic question comprises of a causal inference. This is where we try to find out what impact that these outcomes have had on the target population. However such an endeavour raises the challenge of excluding all the other factors except the intervention so as to quantify the effect of a program on the population. Impact assessment methods are thus used to exclude other factors that may have brought about a similar impact. In an effort to exclude these factors the ideal measurement would be looking at the same individual at the same time but at different points of the intervention. This would give us the impact of the program since we would be comparing what the individual would have been without the intervention and what he would have been with the intervention. But it would be impossible to look at the same individual at the same time but in different situations (Ferraro, 2009). This situation is called a counterfactual and it is the main challenge in any evaluation study.

Thus, the aim of impact assessment methods is solving the counterfactual problem. Evaluation studies accomplish this by coming up with a comparison or control group that that can be compared to the population in a program. This is also a the key problem in evaluation because getting a control group that have the same characteristics as the people in a program can prove to be difficult in a real life situation. A valid control group would be one that has the same

characteristics of the participants in a program except that they did not participate in the program. If the control group in invalid (different in characteristics other than participation from the participants in a program), then the impact will be biased (Winters *et al.*, 2010). In solving any evaluation question, one must come up with a valid control group that allow for the estimation of the counterfactual. A couple of methods have been applied by scholars worldwide in an effort to construct the counterfactual. There are two main categories of methods used in constructing the counterfactual: experimental methods and non-experimental approaches. The approach used depended on the type of data available.

Experimental approaches apply where the participants and non-participants are randomly assigned. As such, the difference in the two groups is taken as the impact of the program. The analysis of the impact in this case is simple since basic tests of differences between the participants and non-participants give the impact of the program (Winters *et al*., 2011). But having a randomly assigned program is rare in reality especially in implementing it. To overcome this, non-experimental approaches are used. Non-experimental approaches are those where the non-participants are chosen using empirical methods so as to represent a reasonable counterfactual. A review of these two approaches is given below.

2.4.1. Experimental Approach

2.4.1.1. Randomised Selection Method

This method is commonly derived from the program or intervention administrative rules. Most programs have either a limitation in the amount of recourses or operational capacity. Thus this limits the number of participants that can be allowed in a program. A program's administrative rules help in choosing who participates in a particular program. These may include observed characteristics (e.g. age, poverty level), unobserved characteristics (e.g. risk attitude, skills), lottery or even in order of registration to the program. After using the rules to choose those that deserve to be in the program, the assignment to the program is done. Randomized assignment is where the program participants are chosen randomly among the deserving population. This thus creates an estimate of the counterfactual since the people who did not receive treatment but were eligible are used. This is so since after the choice of the target population, everyone had an equal chance of participation in the program. Thus this method

produces an ideal comparison group since the non-participants have the same characteristics as the participants except for participation in the program.

Angrist *et al*., (2002) used the randomised selection method to evaluate the Program for Extending the Coverage of Secondary School in Colombia. This was an appropriate method because due to resource limitation the program was assigned randomly among the deserving population. As such, the deserving but non-beneficiary students were used as the counterfactual. The study found out that the students in the program were 10% more likely to have finished 8th grade. It also found out that the participants were less likely to be married and worked less hours per week than the non participants. Newman *et al*., (2002), using randomized selection method assessed the impact of the Bolivian Social Investment Fund (SIF) on education, health and water supply. The study found out that there was an improvement in infrastructure on the participating schools and a decrease in the school dropout rate. But in some programs, randomized assignment is not done especially when factors such as political influence, rent seeking and corruption are involved. Thus unless the program participants were chosen randomly, this method is not appropriate to use (Barahona, 2010). Thus this is a challenge to evaluators especially when evaluating a program that has been running since the assignment has already been done.

2.4.2. Non-Experimental Approach

2.4.2.1. Matching

This method relies heavily on observed characteristics in order to construct a control group that acts as the counterfactual. In respect to this, the method makes an assumption that there are no unobserved characteristics between the participants and the non-participants that is correlated with the outcome being measured (Heckman *et al*., 1998). By using the observed characteristics, matching uses statistical techniques to construct a control group from non-participants that has similar characteristics as participants in a program. Thus the impact is measure by comparing the average outcome for the non-participants and the average outcome among the statistically matched non-participants based on observable characteristics. One of the most common methods of matching is the propensity score matching developed by Rosenbaum and Rubin (1983). The method is often preferred since it matches the participants and non-participants by creating a common probability of participation using observable characteristics which is called the propensity score. The non-participants with the same or closest propensity

score produces an estimate of the counterfactual. The average outcome of participants and non-participants with the same score are then compared to get the impact of an intervention. A detailed structure of the propensity score matching is given in Chapter 3. Mendola (2007) used the propensity score matching method to evaluate the impact of technology adoption on poverty alleviation strategies in Bangladesh. The results of the study found that there was a positive effect of agricultural adoption on farm household wellbeing and thus contributing to poverty alleviation at the household level.

2.4.2.2. Regression Discontinuity

This method is used in evaluation of programs that have a continuous index with a specific cut-off upon which participants and non-participants are selected (Imbens and Lemieux, 2008). For example in regard to income, the total household income can be used as the index. Therefore, households having below Kshs. 10, 000 per month are included in the program and those above it are excluded. As such, the variable or index in question must have the ability to rank the target population. Ranking is important in this method since the ranks at the cut-off point are used to estimate the counterfactual. This is used since the participants just below the cut-off point will have similar characteristics with those just above the cut-off point (Lee and Lemieux, 2009). Therefore, the participants are compared to the non-participants who were close to the cut-off point in order to assess the impact. In estimating the effect of financial aid offers at on college enrolment East Coast College, Van der Klaauw (2002) used the regression discontinuity approach. He found that offering financial aid to students affected enrolment and thus an effective tool to compete with other colleges for students. A study by Ludwig and Miller (2007) assessed the impact of the 1965 Head Start funding on a child's life chances. The study found out that the funding had resulted in lower mortality among children as well as a positive effect on educational attainment. Casaburi *et al*., (2012) using a regression discontinuity found out that improvement in rural infrastructure reduced market prices of local crops in Sierra Leone. The price effect was found to be strong in less productive areas and markets far away from major urban centres.

2.4.2.3. Difference-in-Differences

This method estimates the counterfactual for the change in outcome for the participants by calculating the changes for the non-participants. Therefore, the method applies two comparisons to assess the impact of a program. The first comparison is for the participants before

participation and after participation while the second one is a comparison between the participants and the non-participants (Gertler *et al.*, 2011). Thus the counterfactual becomes the change is outcomes for the control group. However, for the control group to be valid, it must be an accurate measure of what would have been if the program had not been implemented. By the fact that only a measurement of the participants and non-participants before and after the program is done, the method doesn't need a specification of the program rules (Donald and Lang, 2007). As such, the impact of the program is measure by the differences between participants and the non-participants and hence the name difference-in-differences. One limitation of this method is that it requires baseline data so as to get the first differences; that is the difference before and after the intervention for both the participants and non participants. A study done in Indonesia by Feder *et al*., (2004) assessed the impact of farmer field schools on yields and pesticide use among farmers. By applying the difference-in-differences method the study found out that there was not significant impact of the program on yield and pesticide use. In a recent study by Petrick and Zier (2011), the difference-in-differences model was used to evaluate the impact of the European Union's common Agricultural Policy (CAP) in Germany in safeguarding jobs in agriculture. By applying the method on panel data, the study found out that the intervention had a zero marginal effect on employment.

2.5 Smart Subsidies Assessment Criteria

There are three criteria upon which smart subsidies' impact can be assessed. These are: efficiency, equity and sustainability.

2.5.1 Efficiency

How efficient a subsidy policy is depends on the reason why the farmers are not using the inputs, in this case, fertilizer or certified seeds. If the reason the farmers are not using these inputs is due to high economic cost of delivering these inputs in comparison to the benefits accruing from using the inputs, then smart subsidies can encourage the adoption of these inputs. However, if the lack or inadequate use of fertilizer and certified seeds is due to market failures caused by such constraints as poor infrastructure and lack of access to credit, then smart subsidies would prove inefficient. This is because although some of the cost of these inputs would be transferred to the government, the costs would still outweigh the economic benefits after the smart subsidy is terminated. Therefore, policies that address market failures would

prove more efficient in promoting input use. However, input subsidies would prove efficient if they solve distortions created by market failures and inefficient if they do not (Baltzer and Hansen, 2011).

2.5.2 Equity

Smart subsidies are seen as a very important tool of shifting resources from the rich to the poor especially when targeting the poor smallholder farmers (Minot, 2009). However, use of smart subsidies as a tool to achieve equity is seen as a trade-off between efficiency and equity. This is so because although the poor smallholder farmers are the ones mostly constrained by market failures such as lack of credit, they may not be endowed with resources such as skills, land or financial resources to use the subsidized inputs efficiently (Ricker-Gilbert and Jayne, 2012). Thus, if the aim of the smart subsidy is pro-poor growth targeting the poor smallholder farmers, even though it increases equity, it does so at the expense of efficiency.

2.5.3 Sustainability

Sustainably of subsidies depends on whether the use of the subsidized inputs and increased productivity remains after programs termination or if the programs benefits surpass the cost of implementing the subsidy. Even if the program benefits exceed its costs, extending the program beyond its time frame is often criticized. The criticism arises due to inefficiency and probability of the program being used for personal or political gains by the persons controlling how the subsidies are targeted (Baltzer and Hansen, 2011).There is therefore need to have an exit strategy and an aim of having a short term effect that will have a permanent impact. Such short term effects include solving of market failures, developing private sector investment in agricultural input industry and smallholder access to agricultural inputs. Evaluations thus assess the potential of smart subsidies having a long term effect on market failures and target population's households.

2.6 Challenges in Evaluation of Agricultural Programs

The process of evaluating agricultural programs often encounters challenges that are specific to agriculture. One major problem involves cropping cycles and seasonality. These two create the problem of timing. In agriculture it takes several cropping cycles to yield impact given that the farmers need to become proficient in using new techniques and learn from one season to

another. In addition, when using a treatment and control approach, the difference in outcomes between the two groups grows with time hence creating challenges in substantiating the impact.

The instability of variables that affect agriculture also poses challenges to evaluation in agriculture. Variables such as weather and prices of inputs are highly unstable and unpredictable in the long run. This affects evaluation by influencing the impact estimates especially the returns on the treatment group (Farley *et al.*, 2012). Self-selection bias is another challenge that agricultural programs pose to evaluation. This is where farmers self-select themselves because of characteristics such as entrepreneurship, personal motivation and distance to training centre. This thus necessitates the evaluation to isolate the impacts of an intervention from the influence of such non-observable characteristics (Gertler *et al.*, 2011).

Another challenge to evaluation created by agricultural programs is spill over effects. This is when populations other than the target group adopt techniques or get inputs that were intended for the target population. Spill over effects become large and explicit especially when it affects the control group resulting in biased estimates of the impacts.

Apart from spill over effect which is a challenge due to how the program implemented, implementation changes in agricultural programs also offers another challenge to evaluation. When a program is restructured to make it more effective, the adjustment creates a challenge to the validity of the evaluation results and also reduces the potential of knowing what worked and what did not (Farley *et al.*, 2012).

2.7 Empirical Estimates of the Impact of Subsidies in Sub-Saharan Africa

Increasing production is one of the goals that most of the subsidies program have hence making production an important variable of assessing the impact of the programs. In Malawi, the subsidy program was found to increase maize production (Holden and Lunduka, 2010a). Ricker-Gilbert and Jayne (2011), using a six year data on fertilizer use found that using an additional kilogram of the subsidized fertilizer in the current year of production increases maize production by 1.82 kilograms in that year while using an additional kilogram of fertilizer for the last three years increases maize production by 3.16 kilograms.

Chibwana *et al.* (2011) used a two stage regression model to control for selection bias to estimate the impact of Malawi's Farm Input Subsidy Program on the allocation decision of farmers in Kasungu and Machinga districts. The study found out that there is a positive

correlation between participation in the program and the size of land allocated to maize and tobacco production. The study also found out that maize yields increased by an average of 447kg/ha for hybrid maize and 249kg/ha for local maize.

Sheahan *et al.* (2012), used data from the nationwide household survey data spanning 13 years to estimate the profitability of nitrogen application rates on maize fields. The study found out that even though fertilizer use was profitable, but this requires adoption of complementary practices such as good management.

In relation to resource use, Chibwana *et al.* (2013) found that subsidies do not lead to increase in land area under cultivation thus saving land resource. However, the same study found that subsidies for tobacco in Malawi had a negative impact on forests due to demand of poles and timber for constructing drying sheds.

Ricker-Gilbert *et al.* (2013) found out that subsidies crowded out commercial fertilizer in Malawi, Zambia, Kenya and Nigeria. Crowding out of commercial fertilizer was particularly exhibited in places where the private sector is less active. The study also found out that subsidized fertilizer may promote use of organic manure.

2.8 Measures of Perception

Studies on perception have been done especially in relation to introduction of a new technology or practice. These studies have used such models as Multinomial Logit and the Tobit model (Joshi and Pandey, 2005; Kristjanson *et al.*, 2005; D' Antoni *et al.*, 2012). However, since this study is neither based on introduction of a practice or technology or adoption study, these two models cannot be applied.

The Likert scale has been widely used in economics to gather information about attitudes feeling and perception (Likert, 1932). It ranks the responses on a scale and hence helps a researcher to order them. The analysis of the responses was done through summation of the questions regarding perception (Likert, 1932). The responses were subjected to a reliability test to check if they are consistent in measuring perception using the Cronbach's alpha (Cronbach, 1951). Cronbach (1951) defined the Cronbach's alpha as:

$$\alpha = \frac{K\bar{c}}{(\bar{v}+(K-1)\bar{c})} \quad (1)$$

Where K is the items to be summated, $\bar{c}$ is the average of all covariance's between the items across the sample, $\bar{v}$ is the average variance of each item and 1 is a constant.

The Cronbach's alpha reliability coefficient ranges between 0 and 1. The closer the Cronbach's alpha coefficient is to one, the greater the internal consistency. If the Cronbach's alpha is > .9, then the internal consistency is excellent, if it's between 0.89-0.8 it's good, if it's between 0.79-0.7 it's acceptable, if it's between 069-0.6 it's questionable, if it's between 0.59-0.5 it's poor, and if its >0.5 it's unacceptable (George and Mallery, 2003).

2.9 Agricultural Subsidy, Food Security and Income

Prior to the 2008 food crisis, there were assumptions that the cause of food insecurity in many countries was a matter of distribution and access which could be solved by open markets. The 2008 food crisis challenged this assumption and the world has refocused again to food production (Gregory *et al.*, 2011). During the crisis, the world became aware that having enough funds set aside for food does not necessarily translate to food security since countries with the resources to buy food could not access it due to trade barring policies and low production (Headey *et al.*, 2009). As a result, countries are endeavouring to become food secure, and increasing production is one of the major goals. To achieve this, there is need to deal with constraints to food production such as technical constraints where the farmers lack the skill, finances and knowledge to increase production (Godfray *et al.*, 2010). To overcome these constraints especially in a region like SSA where a majority of the producers are not resource endowed necessitates an external intervention. This renewed need of external interventions has recalled the use of subsidies in counteracting the earlier stated constraints.

Moreover, most subsidy policies are designed to increase food security through increase in production as well as reduce poverty through increasing the farmer's income. However, in a study conducted by Ricker-Gilbert and Jayne (2012), it is emerging that it is very difficult to increase production and income using a single subsidy policy. The study found out that if the aim of a subsidy is to raise incomes, then cash transfers to poor farmers is more effective than fertilizer subsidies because of constraints such as poor management and poor soil quality due to nutrient mining over the years. The study also found that targeting more productive farmers leads to a higher increase in production in comparison to targeting resource poor farmers. Consequently, it is more logical to give subsidies to productive farmers rather than unproductive poor farmers. This raises the question of whether subsidies program can both achieve increase in production and increase incomes if the poor farmers undergo training to build capacity. Given

that *Kilimo Plus* program entails training the farmers, the results of the study help to substantiate whether subsidies can increase production and income at the same time.

2.10 Household Food Security Measures

Over the years, there has been a shift of focus from national food security to household and individual food security. This has been brought about by the realization that national food security does not translate to individual or household food security. Household food security measures encompass assessing indicators such as food production, household expenditure, household income, anthropometric measures and caloric consumption.

Determining the household food security using consumption surveys is one of the methods used. However, consumption is usually an outcome of access, acquisition and allocation which makes this measure to assume that these factors are given. Household income can be used as a measure of food security when the income is limited to income spent on food. The method has however been criticized because the income spent on food depends on household behaviour and also the cost of other goods and services (Pinstrup-Andersen, 2009).

Anthropometric measures give a good indication of an individual or household food security but the method is usually costly especially for a large population and also faced by the challenge of some of the measure such as stunting being an indication of childhood food insecurity rather than present food insecurity.

This has brought about the invention of tools such as the food insecurity perception (FI perception) which has been used in the past as a measurement scale of food security in many countries including developing countries. It is a low cost and easy to use method that is highly reliable and consistent indicator of households under the risk of food insecurity. FI perception entails 15 questions and gives four levels: food security, light food insecurity, moderate food insecurity and serious food insecurity. The questions asked are:

1. Whether the household had concern about enough food in the last 12 months
2. Whether the food has run out in the last 12 months
3. Whether the household had a healthy eating habit in the last 12 months
4. Whether the household had food for children in the last 12 months
5. Whether the household had healthy food for children in the last 12 months

6. Whether child has not eaten enough in the last 12 months
7. Whether adult skipped meals in the last 12 months
8. Whether adult(s) had eaten less in the last 12 months
9. Whether the adult was hungry in the last 12 months
10. Whether household members lost weight in the last 12 months
11. Whether adult didn't eat all day long in the last 12 months
12. Whether the household reduced children food in the last 12 months
13. Whether the children skipped meals in last 12 months
14. Whether any child had been hungry because of lack of food in the last 12 months
15. Whether child didn't eat all day long in the last 12 months.

Correa (2007) suggests the use of the scale on the basis of the number of questions answered. If the respondent answers all the questions negatively, then they are in the level of food security, if they answer between one to five of the questions positively then they are at light food insecurity level, if they answer between six and ten of the questions then they are at moderate food insecurity and if they answer between eleven and fifteen questions positively, then they are at the serious food insecurity level.

Another measure used to assess household food security is dietary diversity. It entails the number of different foods consumed by a household member over a specific time period. At the household level, dietary diversity measures the access to food of the household. There is also evidence that dietary diversity is associated with per capita consumption which is a proxy for income and energy availability thus making it a useful indicator of household food security (Ruel, 2004). Hoddinot and Yohannes (2002) found that a one percent increase in dietary diversity is associated with a one percent increase in per capita consumption. However, there is no standard level at which a household can be classified as having adequate or inadequate dietary diversity and it also doesn't consider food consumed out of home. Thus it is recommended to use dietary diversity together with another measurement tool. The study used dietary diversity together with food insecurity perception to measure food security.

2.11 Measures of Household Income

Awotide *et al.* (2011) used per capita income to analyse the impact of access to subsidized rice seeds on households' income in Nigeria. Per capita income is the mean income of

the household calculated by dividing the income of the household by the number of household members and it adjusts income for household size (Datta and Meerman, 1980). However, the method assumes economies of scale by assuming that the household income needs grow proportionally and that the age of the individual does not matter.

To correct for this, the "OECD modified scale" that was proposed by Haagenars *et al.* (1994) was used that gives the household head a value of one, additional adult 0.5 and 0.3 to each child which gives an equivalence elasticity of 0.53 (OECD, 2009). Thus this equivalence elasticity was used to adjust the household income using the formula by Buhman *et al.* (1988):

$$\bar{M}^h = \frac{M^h}{[d^h]^{\varepsilon}} \quad (2)$$

Where $\bar{M}^h$ is the mean adjusted household per capita income, M^h is the household income, d^h is the number of household members and ε is the equivalence elasticity equal to 0.53.

2.12 Theoretical Framework

This study is grounded on the rational choice theory. The farmer is faced with a set of alternatives $X_1 \ldots, X_n$. But since the decision to participate has only two sets of alternatives, then the sets can be represented as follows:

Thus let $A=\{X_1; X_2\}$ (3)

Where A is the set of alternatives, X_1 is the decision to participate and X_2 is the decision not to participate. However, rationality includes considering the end and long-term results versus short-term results. The end and long-term results are usually not known with certainty and they are based on ones beliefs (Grune-Yanoff, 2010a), then X_1 and X_2 become lotteries and thus equation (3) becomes:

$A= \{X_1, p; X_2, p\text{-}1\}$ (4)

Where p is the probability such that $1 \geq p(X) \geq 0$ and $p + (1\text{-}p) = 1$.

In relation to utility, utility maximization is used instead of profit maximization because the farmers in *Kilimo Plus* are both producers and consumers (Caviglia-Harris, 2003), and thus the probability relates to the outcome as:

$$U(X) = \sum_i [p_i \times U(X_i)] \quad (5)$$

This is because the utility of a lottery is equal to the sum of outcome utilities weighted by the probability of that outcome.

Thus the farmer will choose the alternatives depending on the utility that he or she derives from that alternative such that if:

$$U(X_1) = \sum_1[p_1 \times U(X_1)] > U(X_2) = \sum_2[(1 - p_1) \times U(X_2)] \quad (6)$$

Then the farmer chooses X_1 and vice versa.

But the utilities $U(X_1)$ and $U(X_2)$ are in the context of uncertainty since the farmer does not know with certainty the outcome and also a summation of utilities derived from the decision (for example higher production, higher income), thus utility derived is expected utility (Varian, 2010). Thus the expected utility can be computed as:

$$E\,[U(X_1)] - E\,[U(X_2)] > 0 \quad (7)$$

$$E\,[U(\quad_1)] - E\,[U(X_2)] < 0 \quad (8)$$

Hence if A* be a latent variable denoting *Kilimo Plus* participation or not, and A_i be the indicator of whether household *I* participates or not, so that A_i =1 if it participates and A_i =0 if not, then:

$$A_i = A_i = 1 \quad E\,[U(X_1)] - E\,[U(X_2)] > 0; \text{ and} \quad (9)$$

$$A_i = A_i = 0 \quad E\,[U(X_1)] - E\,[U(X_2)] < 0 \quad (10)$$

Equation 9 and 10 thus show the dependent variable as dichotomous in nature, with the values 1 if the household participates and 0 if not, thus allowing us to use binary choice models.

Equation 9 and 10 show that a household will participate in the program if the utility derived from participating is higher than the one derived from participating (Caviglia-Harris, 2003).

2.13 Conceptual Framework

The conceptual framework for this study is shown in Figure 1. The perception of the farmer towards the *Kilimo Plus* program is conceptualised to be affected by the farmer's socio-

economic factors as well as by the source of learning of the *Kilimo Plus* program. Consequently, the source of learning influences the farmer's awareness about the program. An awareness of the program influences the farmer's participation which also influences his/her perception. For the participants, accessing fertilizer, certified seeds and training also has an effect on their perception of the program. Access to fertilizer, certified seeds and training is hypothesized to lead increased production and consequently to the farmer's food security and high income. Increased production, food security and income are also conceptualised to influence perception.

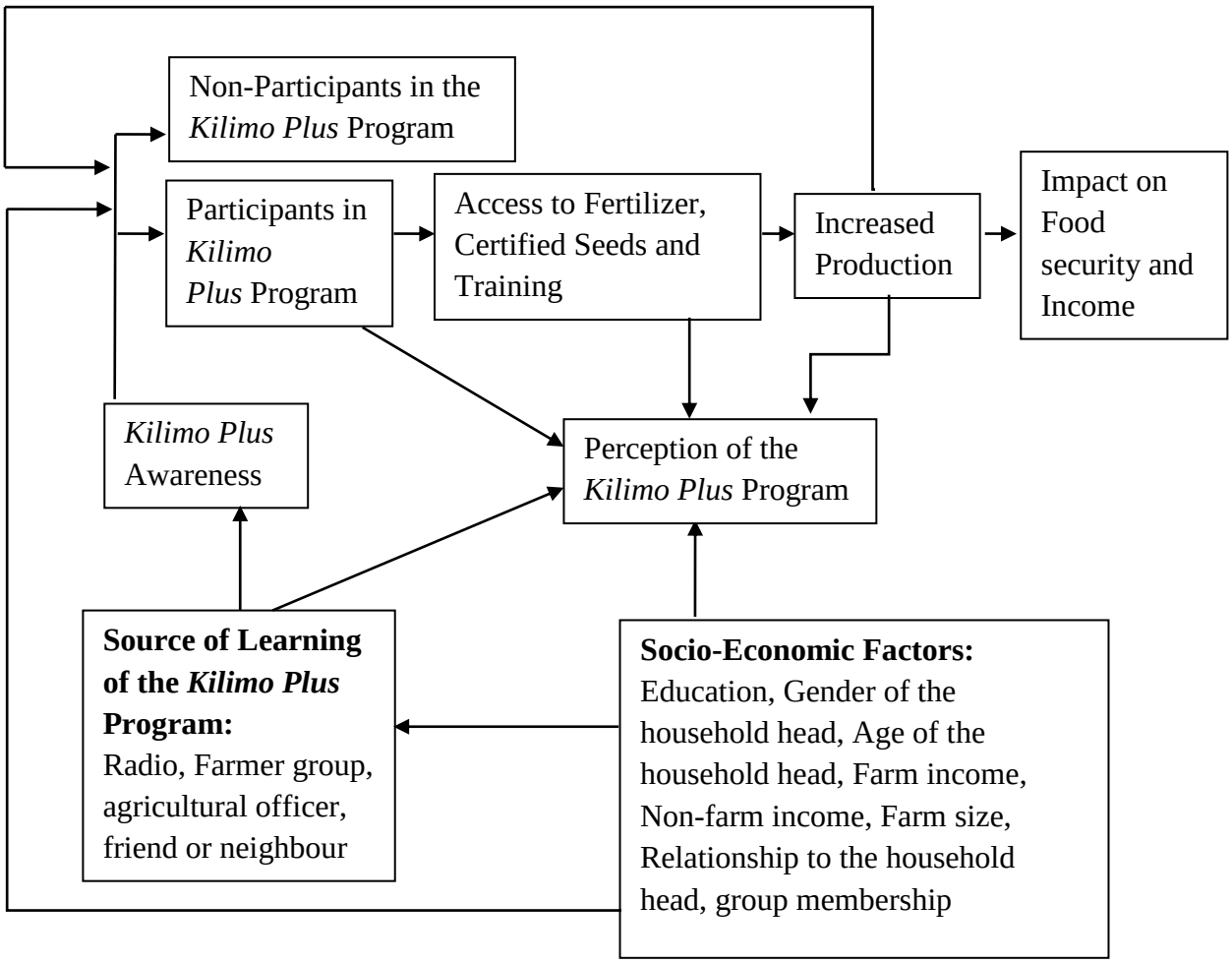

Figure 1: Conceptual Framework

Source: Author's Conceptualization

CHAPTER THREE
METHODOLOGY

3.1 Study Area

The study was carried out in Nakuru North District which is one of the four districts in Nakuru County as shown in Figure 2. It has three divisions, six locations and fourteen sub locations. It covers an area of 593.3 km^2 of which 51, 891 ha is arable land and a population of 211, 691 people comprising of 51, 224 households (MoA, 2010). The district traverses agro ecological zone 3, 2 and 1 and specifically lies between Upper Highland (UH 1) and Upper Midland (UM 5) sub zones. It has an altitude of 1660 to 3000 metres above sea level, temperatures ranging from 10 to 17.8 ^oC and an annual rainfall of 680 to 1800mm.The soils in the district are mostly volcanic soils that are fully weathered supporting such crops as wheat, Irish potatoes, sweet potatoes, sorghum finger millet, cabbages, kales, spring onions, passions fruits, carrots, tomatoes, maize and beans as the major crops in the district.

3.2. Research Design

This study applied a cross-sectional research design (Busk, 2005). As such, the data were based on the existing differences within the sample rather than the change due to the *Kilimo Plus* subsidy program. Thus this study does not measure the impact of the *Kilimo Plus* program over time but rather at the time this study was done.

3.2.1. Population

The target population of the study were both participants in *Kilimo Plus* program and non-participants. The participants were the treatment group while the non-participants acted as the control group.

3.2.2. Sampling Procedure and Sample Size

The formula by Yamane (1967) was used to determine the total sample size which includes the participants and non-participants population:

$$n = \frac{N}{1+N(e^2)} \quad (12)$$

Where *n* is the sample size, *N* is the population size, 1 is a constant and *e* is the level of significance (confidence interval of 95%). Since there are 51,224 households in Nakuru North, then the sample was:

$$n = \frac{51{,}224}{1 + 51{,}224(0.05^2)}$$

$$n = 396.9007$$

$$n \approx 397$$

Multi stage sampling was used in this study. The first stage was to purposively select Nakuru North district since it was one of the districts that received the *Kilimo Plus* program inputs for two years. In the second stage, purposive sampling was used to select farmers in the district who were maize farmers since the *Kilimo Plus* program targeted maize farmers in the district. In the third stage, systematic random sampling was done to get the farmers who had participated in the *Kilimo Plus* program. This method was preferred since the list of the farmers was available. The list of farmers (sampling frame) was accessed from the district agricultural officer and comprised of 61 farmers of which 28 participants were selected for the study. The first farmer was chosen at random while subsequent farmers were chosen in accordance to the formula by Black (2004):

$$k = \frac{N}{n} \tag{11}$$

Where *k* is the sampling interval, *n* is the sample size and *N* is the population size. An element was chosen from the list at random and every k^{th} element in the sampling frame selected. The final stage was to select 369 non-participants who were sampled using simple random sampling as long as they are not in area where the subsidy was given. However, to ensure that the degrees of freedom and good matches between the participants and non-participants are obtained, 372 non-participants were selected thus bringing the whole sample size to 400. The non-participants (control) was kept as large as possible to increase the likelihood of finding good matches for the participants (Baser, 2006).The ratio between the non-participants and participants was 93:7 for respectively. This shows that each participant had a probability of being matched with thirteen non-participants in the propensity score matching.

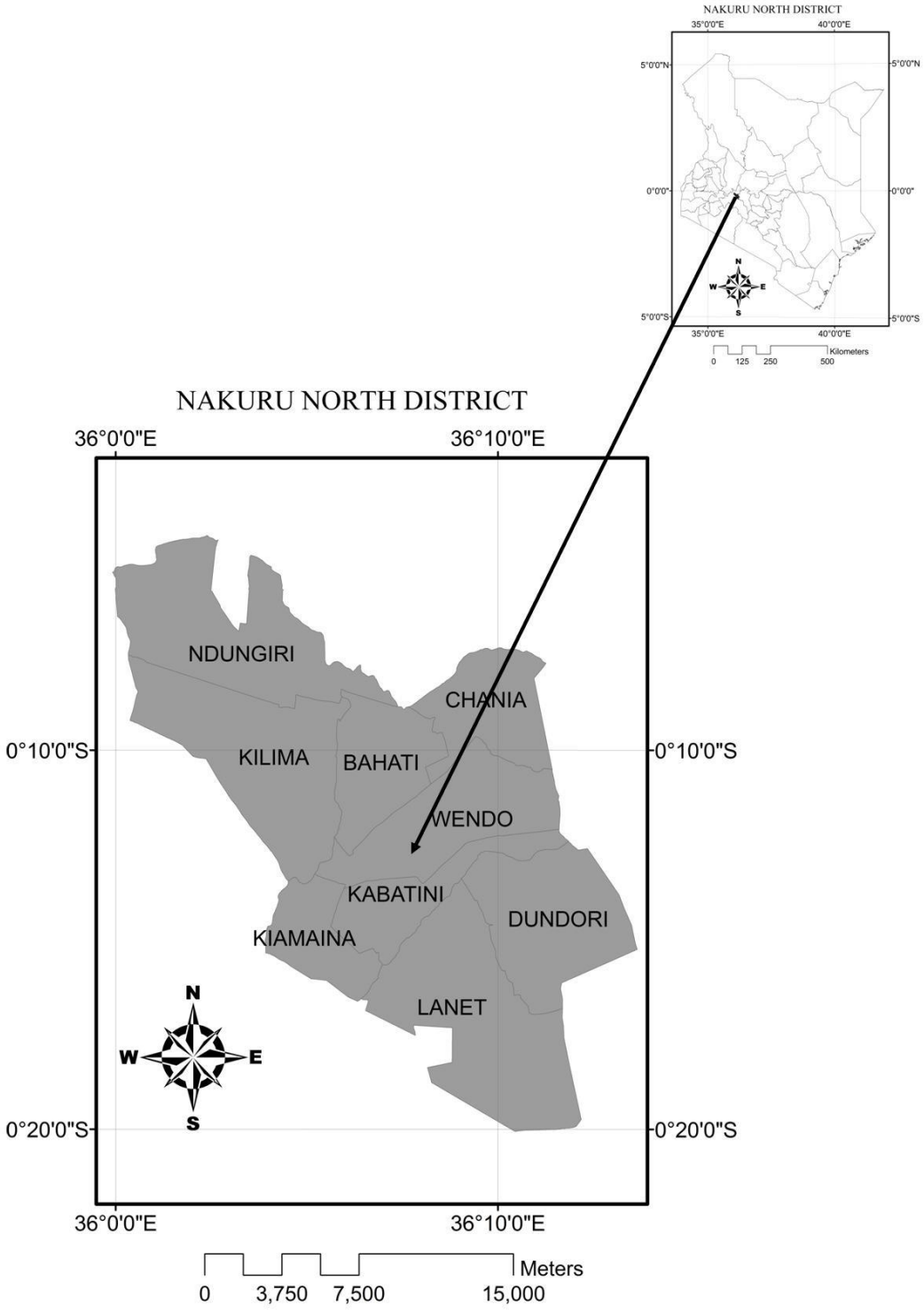

Figure 2: Map of the Study Area

Source: World **Resources** Institute (2013)

3.2.3. Data Collection

Data for the study were collected through interviewing the farmer's with the aid of a semi-structured questionnaire. The information collected was on their perception, institutional factors relating to them and their socio-economic characteristics.

3.3. Data Analysis

Stata (Version 9) and Statistical Package for Social Scientists (SPSS, Version 17) software programs were used in the analysis and presentation of the study data and findings.

3.3.1. Descriptive Analysis

The socioeconomic characteristics of the farmers were also analysed using descriptive statistics as well as objective one. Descriptive statistics comprised of means, median, mode, and standard deviation.

3.3.2. Ordered Probit Model

Objective two was analysed using an ordered probit model. The probit model was chosen over the ordered probit model since it gives more consistent results in situations where populations have an order and there exist individual effects (Hahn and Soyer, 2005). Hence, since perception depends on individual experience and insight, the model was deemed more appropriate than an ordered logit. To determine the perception of farmers towards the *Kilimo Plus* program, the farmers were asked to rate the program based on a number of questions relating to the program on Likert Scale with five ranks, 0 to 4 where: 0 is poor, 1 fair, 2 average, 3 good and 4 excellent. An ordered probit model was then used to determine the relationship between perceptions and the factors hypothesized to influence it. Thus:

$$y^* = \beta' X + e \tag{13}$$

Where y^* is the farmers perception ranging from 0 (poor) to 4 (excellent), β is the parameter to be estimated and e is the error term that is normally distributed with a mean of zero and variance of one. The choices will thus be:

$$y^* \begin{cases} 0, if\, y = 0 \\ 1, if\ 0 < y \le \mu_1 \\ 2, if \mu_1 < y \le \mu_2 \\ 3, if \mu_2 < y \le \mu_3 \\ 4, if \mu_3 < y \le \mu_4 \end{cases} \quad (14)$$

Whereμ's are unknown parameters to be estimated. The probability of a farmer's choice falling between each category is:

$$\begin{aligned} &\Pr ob(y = 0|\,\mathrm{X}) = F(-\beta'\mathrm{X}), \\ &\Pr ob(y = 1|\mathrm{X}) = F(\mu_1 - \beta'\mathrm{X}) - F(-\beta'\mathrm{X}), \\ &\Pr ob(y = 2|\mathrm{X}) = F(\mu_2 - \beta'\mathrm{X}) - F(\mu_1 - \beta'\mathrm{X}), \\ &\Pr ob(y = 3|\mathrm{X}) = F(\mu_3 - \beta'\mathrm{X}) - F(\mu_2 - \beta'\mathrm{X}), \\ &\Pr ob(y = 4|\mathrm{X}) = 1 - F(\mu_3 - \beta'\mathrm{X}). \end{aligned} \quad (15)$$

Where F (.) is the cumulative probability distribution written as:

$$P_i = F(\beta'\mathrm{X}) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta'\mathrm{X}} e^{\frac{-z^2}{2}}\, dz, (z \sim N(0,1)) \quad (16)$$

Since the maximum likelihood estimation is used to estimate β and μ, then the probability equation can be reduced to:

$$\mathrm{Prob}(y = n) = \Phi(\mu_n - \beta'\mathrm{X}) - \Phi\left(\mu_{n-1} - \beta'\mathrm{X}\right), \quad \mathrm{n} = 0 \ldots 4 \quad (17)$$

Where Φ is the cumulative distribution function, $\mu_0 = 0$ and $\mu_4 = +\infty$ and $\mu_0, \mu_1, \mu_2, \mu_3$ and $\mu_4$are the five thresholds between which the categorical responses are estimated with a maximum likelihood function (Mckelvey and Zavoina, 1975):

$$L = \prod_{i=1}^{n} \prod_{j=1}^{m} \left[\Phi\left(\mu_j - \beta'\mathrm{X_i}\right) - \Phi(\mu_{j-1} - \beta'\mathrm{X_i})\right]^{Z_{ij}} \quad (18)$$

But the estimated coefficients do not represent the effect of an individual variable on the farmer's perception; hence the marginal effects will be calculated to establish the effect (Greene, 2002). The marginal effect is calculated as:

$$\frac{\partial \text{Prob } (y=n)}{\partial \text{X}} = -[\Phi(\mu_n - \beta'\text{X}) - \Phi(\mu_{n-1} - \beta'\text{X})]\beta, \qquad n = 0 \dots 4 \tag{19}$$

The goodness of fit is calculated as:

$$\text{p}^2 = 1 - \left[\frac{\ln L_b}{ln\, L_0}\right] \tag{20}$$

Where L_b is the log likelihood at convergence and L_0 is the log likelihood computed at zero and $0 \leq p^2 < 1$. If all the coefficients are zero, the goodness of fit is zero. The goodness of fit cannot be equal to one but a value close to one indicates a very good fit (Duncan *et al.*, 1998).

The model is specified as:

$$Perception = \beta_0 + \beta_1 GNDR + \beta_2 EDUC + \beta_3 HSHLDS + \beta_4 AGE + \beta_5 FAMINC + \beta_6 NFAMINC + \beta_7 RISK + \beta_8 WEALTH + \beta_9 EXTEN + \beta_{10} GRP + \beta_{11} MEDIA + \beta_{12} DSTMKT + \beta_{13} CREDIT + e \tag{21}$$

Where perception is the dependent variables, $\beta_1, \beta_2 \dots \beta_n$ are the parameter to be determined and e is the error term. The expected sign of the variables in the model and explanations are explained in Table 1.

Table 1: Description of Factors that Influence Smallholder Farmers' Perception of *Kilimo Plus* Program

Variable	Variable Description	Measurement of Variable	Expected Sign
Perception	Perception of the smallholder farmers towards the *Kilimo Plus* subsidy program	Ordered responses between0 to 4 where: 0 is poor, 1 fair, 2 average, 3 good and 4 excellent	Dependent variable
TREATMENT	Treatment variable (Whether you were in the *Kilimo Plus* program or not)	Dummy Variable Participants = 1,Non-participants = 0	+
HOUSEHOLDSIZE	Household size	Continuous Variable	+/_
MALE	Gender of the household head	Dummy Variable Male=1, Female =0	+
AGE	Age of the household head	Continuous Variable	+
PRDNINC	If production increased (how much was the surplus maize)	Continuous Variable (Bags)	+
FARMINC	Farm income	Continuous Variable (Kshs)	+
NONFARMINC	Non-farm income	Continuous Variable (Kshs)	+/-
FARMSIZE	Size of farm	Continuous Variable (acre)	+/-
RELHHHEAD	Household head	Dummy Variable Household head = 1, Otherwise =0	+/-
RELHHSPOUSE	Spouse of the household head	Dummy Variable Spouse of the household head = 1, Otherwise =0	+/-
RELHHCHILD	Child of the household head	Dummy Variable Child of the household head = 1, Otherwise =0	+/-
RELHHPARENT	Parent of the household head	Dummy Variable Parent of the household head = 1, Otherwise =0	+/-

Table 1: Continuation

Variable	Variable Description	Measurement of Variable	Expected Sign
RELHHNIECE	Niece of the household head	Dummy Variable Niece of the household head = 1, Otherwise =0	+/-
RELHHBROSISINLAW	Brother-in-law or Sister-in-law of the household head	Dummy Variable Brother-in-law or Sister-in-law of the household head = 1, Otherwise =0	+/-
INCOMPLETEPRIMARY	Having an incomplete primary school education	Dummy Variable Incomplete primary school education = 1, Otherwise =0	-
COMPLETEPRIMARY	Having completed primary school education	Dummy Variable Complete primary school education = 1, Otherwise =0	+
INCOMPLETESECONDARY	Having an incomplete secondary school education	Dummy Variable Incomplete secondary school education = 1, Otherwise =0	+
COMPLETESECONDARY	Having completed secondary school education	Dummy Variable Complete secondary school education = 1, Otherwise =0	+
TRAINING	Training on farming and input use	Dummy Variable Trained = 1, Not trained =0	+
LEARNSOURCEFRIENDNEIGH	Learnt of the *Kilimo Plus* program from friend or neighbour	Dummy Variable Learnt from friend or neighbour = 1, Otherwise =0	+/-
LEARNSOURCEGRP	Learnt of the *Kilimo Plus* program from farmer group	Dummy Variable Learnt from farmer group = 1, Otherwise =0	+/-
LEARNSOURCERADIO	Learnt of the *Kilimo Plus* program from the radio	Dummy Variable Learnt from the radio = 1, Otherwise =0	+/-

3.3.3. Average Treatment Effect (ATE)

ATE approach was used to analyse objectives three and four. ATE is defined as the "average partial effect for a binary variable" (Wooldridge, 2002). The main problem in evaluation is how to handle self-selection and counterfactual setting. If the impact of treatment on individual *i* is denoted by *δi*, then the equation can be written as:

$$\partial_i = Y_{1i} - Y_{0i} \tag{22}$$

Where Y_{1i} is the outcome in case of treatment and Y_{0i} is the outcome in the absence of treatment. This is the basic formula of ATE but it averages the impact across individuals and thus the equation is:

$$ATE = \mathrm{E}\,(\partial) = \mathrm{E}\,(\mathrm{Y}_1 - \mathrm{Y}_0) \tag{23}$$

Where E denotes the average or expected value.

However, in this study, we are interested on the programs impact on the individuals who participated in it which is the Average Treatment Effect on the Treated (ATT). While the ATE compares mean outcome if entire population had received treatment to the mean outcome if entire population had not received treatment, the ATT compares mean outcomes for individuals who in reality received treatment to the mean outcomes if these same individuals had instead not received treatment (DuGoff *et al.*, 2013). Thus, in the study we are interested in the impact of the subsidy program on the individual household rather than the population. Furthermore, Heckman (1997) observes that the ATE may not be relevant to policy makers because it includes the effect on persons for whom the program was never intended for.

If D denotes the value if treated or not such that D=1 if treated and D=0 if not, then:

$$ATT = \mathrm{E}\,(\mathrm{Y}_1 - \mathrm{Y}_0|\mathrm{D} = 1) \tag{24}$$

But since the average of differences is the difference of averages, then ATT can be written as:

$$ATT = \mathrm{E}\,[(\mathrm{Y}_1|\mathrm{D} = 1) - (\mathrm{Y}_0|\mathrm{D} = 1)] \tag{25}$$

But we cannot observe the second term in equation 25 since it is a counterfactual of the outcome of the individual who was treated if they had not been treated. But we can observe the term$\mathrm{E}\,(\mathrm{Y}_0|\mathrm{D} = 0)$, which is the value of Y_0 for the untreated individuals and thus get the difference as:

$$\Delta = \mathrm{E}(\mathrm{Y}_1|\mathrm{D}=1) - \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=0) \quad (26)$$

The difference in equation 26 is the selection bias which the difference between the counterfactual for treated individuals and the observed outcome for the untreated. This can be shown by adding and subtracting the term $E(Y_0|D=1)$ in equation 25 as shown below:

$$\Delta = \mathrm{E}(\mathrm{Y}_1|\mathrm{D}=1) - \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=1) + \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=1) - \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=0)$$

$$\Delta = \mathrm{ATT} + \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=1) - \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=0)$$

If $\lambda = \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=1) - \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=0)$, then

$$\Delta = \mathrm{ATT} + \lambda \quad (27)$$

The symbol λ is the selection bias. If λ is zero, then ATE is an unbiased estimator of ATT:

$$ATE = \mathrm{E}(\mathrm{Y}_1|\mathrm{D}=1) - \mathrm{E}(\mathrm{Y}_0|\mathrm{D}=0) \quad (28)$$

But the term λ is often not equal to zero because of farmers self-selecting themselves in a program due to characteristics such as entrepreneurship, motivation and risk attitude, and thus the difference in means (ATE) will be a biased estimator of ATT. This is the main challenge of evaluation in trying to make the selection bias be equal to zero.

This is done through random assignment which makes sure that the treatment status (D) is not correlated with other observable or unobservable variables and thus the outcomes are statistically independent of the treatment category (Winters *et al.*, 2010). This makes sure that the characteristics of the treated and the untreated is the same (statistically equivalent), thus the groups will be identical except for the treatment category:

$$E(Y_0|D=1) = E(Y_0|D=0) \quad (29)$$

Thus making it possible to replace the unobservable term $E(Y_0|D=1)$ with the observable term $E(Y_0|D=0)$ to estimate ATT by ensuring the selection bias is equal to zero.

3.3.3.1. Propensity-Score Matching (PSM)

This method was chosen due to various advantages that it has over other methods. PSM being a non-experimental method, it is appropriate for this study because the program does not have experimental farmers who act as the control group.

As well, the difference-in-difference method was also not appropriate because it necessitates baseline data about the farmers' income and food security status before the treatment. Instrumental variables and encouragement design approach can also be used in this

study, especially because it solves the problem of self-selection discussed in ATE, but finding an appropriate instrumental variable that affects participation and not the dependent variable on an ex-post evaluation is difficult. For example, if distance from training centre is used, the distance may act as an incentive for farmers close to the centre to self-select themselves into the training and hence participation. Also, most areas for training in the rural areas (for example schools), influence the development of economic centres which may influence a famer's participation due to economic services such as access to agro-dealers. The method also can only estimate a Local Average Treatment Effect, which means the results are only relevant to farmers affected by the instrument (Angrist, 2001).

On the other hand, PSM was chosen instead of regression discontinuity method because regression discontinuity needs a large number of farmers next to the discontinuity to draw meaningful decision but this is difficult because the further one moves from the discontinuity line the more the variable characteristics vary. Regression discontinuity also yields a local treatment effect just like instrumental variable approach.

PSM assumes that farmers who receive treatment and those who do not differ not only in treatment but also in characteristics that affect participation and the outcome. It thus seeks untreated farmers who have the same characteristics to the treated farmers and matching them using propensity scores and thus creating a "quasi-experiment" because the control group (untreated farmers) are statistically equivalent to the treated farmers (Winter *et al.*, 2010).

The propensity score was used to estimate the probability of receiving treatment ($P_i = 1$) given observed characteristics (X):

$$\Pr(P_i) = \Pr(P_i = 1|X) \tag{30}$$

Since $0 < P_i < 1$, the conditional probability of participation (propensity score) was estimated using a probit model where the dependent variable is a dummy variable equal to one if the farmer participated and zero otherwise (Wooldridge, 2002). The independent variables are the characteristics that determined program participation thus replicating the selection process. By using these characteristics, selection bias is solved since we are using the administrative rules in the program and hence the farmers do not self-select themselves in the program.

PSM was used as suggested by Rosenbaum and Rubin (1983), to match the scores of those who were treated and those who were not treated. The outcome of the treated and untreated group and the difference between the two is the measure of the impact attributable to the *Kilimo Plus* program. Taking the mean of these individual impacts thus yields the estimated ATE (Gertler *et al.*, 2011):

$$ATE = E[Y_1(t = 1, D = 1) - Y_0(t = 1, D = 0)] \quad (31)$$

Where Y_1 is the outcome for the treated, Y_0 is the outcome for the non-treated, $t=1$ represents the period post-treatment, $D=1$ represents project participation and $D=0$ represents non-participation.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Descriptive Analysis

For continuous variables, the *t*-test was used to test if the means were significantly different for the participants and non-participants as suggested by Bower (2003a). In the case of categorical variables, the *Chi*-square test was used to test if the variables were significantly different between the participants and non-participants. However, where the number of observations was too small, such that one of the categories had less than five observations, the Fisher's exact test was used instead of the *Chi*-square test. The Fisher's exact test was preferred over the *Chi*-square test because when the number of observations is small, the *Chi*-square test may produce misleading results as advocated by Bower (2003b).

The mean household size for the sample was 6.39 persons as shown in Table 2. The participants of the *Kilimo Plus* program had 5 persons per household and the non-participants 6.5 persons. The t-value was significant at 1% showing that the non-participants had a larger household size than the participants. The mean age of the household head was 45.68 years with the non-participants having a mean of 45.11 years and the participants having a mean of 53.21 years as shown in Table 2. The difference in the means was significant at 10% thus showing that the participants of the *Kilimo Plus* program were significantly older than the non-participants.

Table 2: Household Size, Age and Farm Size of Sample Households

Variable	Mean N=400			*t*-value
	Pooled data	Non-participants n=372	Participants n=28	
Household size	6.39	6.50(2.134)	5.00(1.826)	-3.614***
Age	45.68	45.11(16.233)	53.21(14.551)	2.565*
Farm size	1.3706	1.3743(0.931)	1.3214(0.476)	-0.297

Source: Survey data, 2013.

Note: Figures in the parentheses are the standard deviation associated with the means. ***P < 0.01, **P < 0.05 and *P < 0.10 mean significant at 1%, 5% and 10% probability levels, respectively

The mean land holding was 1.37 acres per household as shown in Table 2. This shows that most of the respondents were smallholder farmers which concur with the countries estimation of 87% of the farmers in the country owning 2.5 acres or less. The participants in the *Kilimo Plus* program had a smaller size of land with a mean of 1.32 acres while the non-participants had a mean land size of 1.37 acres. But the difference in land holding between the participants and non-participants was not significantly different.

Income of the sampled households is shown in Table 3. There was no significant difference between the participants and non-participants farm, non-farm and total income.

Table 3: Results of Income of the Sample Households

Variable (Kshs)	Percent (N=400)			Fisher's Exact Test
	Pooled data	Non-participants n=372	Participants n=28	
Farm income				
<10, 000	92.00	91.94	92.86	
10, 000-19, 999	5.00	4.84	7.14	0.727
20, 000-29, 999	2.75	2.96	0.00	
40, 000-49, 999	0.25	0.27	0.00	
Non-farm income				
<10, 000	90.73	90.30	96.43	
10, 000-19, 999	3.76	4.04	0.00	
20, 000-29, 999	2.76	2.70	3.57	
30, 000-39, 999	1.25	1.35	0.00	0.801
50, 000-59, 999	1.00	1.08	0.00	
60, 000-69, 999	0.25	0.27	0.00	
70, 000-79, 999	0.25	0.27	0.00	
Total income				
<10, 000	83.21	82.75	89.29	
10, 000-19, 999	8.52	8.63	7.14	
20, 000-29, 999	4.76	4.85	3.57	
30, 000-39, 999	1.50	1.62	0.00	1.000
40, 000-49, 999	0.50	0.54	0.00	
50, 000-59, 999	1.00	1.08	0.00	
60, 000-69, 999	0.25	0.27	0.00	
70, 000-79, 999	0.25	0.27	0.00	

Source: Survey data, 2013.

About 92% of the sample households had a farm income that was below Kshs. 10, 000 while 5% had a farm income between KShs. 10, 000 and KShs. 19, 999 as shown in Table 3. Moreover, 2.75% of the respondents had a farm income that was between KShs. 20, 000 and

KShs. 29, 999 and 0.25% had a farm income that was between Kshs. 40, 000 and KShs. 49, 999. Around 91.94% of the non-participants had an income that was below Kshs. 10, 000 while for the participants the proportion was 92.86%. The proportion of non-participants and participants that had a farm income of between KShs. 10, 000 and KShs. 19, 999 was 4.84% and 7.14% respectively. For the participants, none of the respondents had a farm income that was higher than KShs. 19, 999. On the other hand, 2.96% and 0.27% of the non-participants had a income that was between KShs. 20, 000 and KShs. 29, 999 and KShs. 40, 000 and KShs. 49, 999 respectively.

As for the non-farm income, 90.73% of the respondents had a non-farm income that was below KShs. 10, 000, 3.76% between KShs. 10, 000 and KShs. 19, 999 and 2.76% between KShs. 20, 000 and KShs. 29, 999. About 1.25% of the respondents had a non-farm income that was between KShs. 30, 000 and KShs. 39, 999, 1% had a non-farm income that was between KShs. 50, 000 and KShs. 59, 999, 0.25 % between KShs. 60, 000 and KShs. 69, 999 and another 0.25% between KShs. 70,000 and KShs. 79, 999. About 90.3% of the non-participants and 96.43% of the participants had a non-farm income that was below KShs. 10,000. For the participants, the other 3.57% of the respondents had a non-farm income that was between KShs. 20, 000 and KShs. 29, 999. As for the non-participants, 4.04%, 2.7% and 1.35% had a non-farm income that was between KShs. 10, 000 and KShs. 19, 999, KShs. 20, 000 and KShs. 29, 999 and KShs. 30, 000 and KShs. 39, 999 respectively. Furthermore, 1.08%, 0.27% and 0.27% of the non-participants had a non-farm income that was between KShs. 50, 000 and KShs. 59, 999, KShs. 60, 000 and KShs. 69, 999 and KShs. 70, 000 and KShs. 79, 999 respectively.

About 83.21% of the respondents had a total income that was below KShs. 10, 000, 8.52% between KShs. 10, 000 and KShs. 19, 999 and 4.76% between KShs. 20, 000 and KShs. 29, 999. Around 1.5%, 0.5% and 1% had a total income that was between KShs. 30, 000 and KShs. 39, 999, between KShs. 40, 000 and KShs. 49, 999, and between KShs. 50, 000 and KShs. 59, 999 respectively. In addition, 0.25% and 0.25% between KShs. 60, 000 and KShs. 69, 999 and between KShs. 70, 000 and KShs. 79, 999 respectively. About 82.75% of the non-participants had a total income that was below KShs. 10, 000, 8.63% had an income between KShs. 10, 000 and KShs. 19, 999 and 4.85% between KShs. 20, 000 and KShs. 29, 999. Furthermore, 1.62%, 0.54%, and 1.08% of the non-participants had a total income between

KShs. 30, 000 and KShs. 39, 999, between KShs. 40, 000 and KShs. 49, 999 and between KShs. 50, 000 and KShs. 59, 999 respectively. The proportion of non-participants who had a total income of between KShs. 60, 000 and KShs. 69, 999 was 0.27% while the ones that had a total income between KShs. 70, 000 and KShs. 79, 999 was also 0.27%.

About 80.8% of sample households were male-headed while 19.2% were female headed. The results are shown in Table 4. The results on education, training and infrastructure are also shown in Table 4. About 13% of the respondents had no formal education, 16.25% had an incomplete primary school education, and 33.5% had a complete primary school education. Furthermore, 11.75% had an incomplete secondary school education, 20.2% had a complete secondary school education, 0.75% had a tertiary polytechnic education, 3.5% had a tertiary college education and 1% had a university education level. Around 11.56% of the non-participants had no formal education as compared to 32.14% of the participants. About 15.86%, 34.68% and 11.83% of the non-participants had an incomplete primary school education, a complete primary school education and an incomplete secondary school education respectively. On the other hand, 21.43%, 17.86% and 10.71% of the participants had an incomplete primary school education, a complete primary school education and an incomplete secondary school education respectively. Only 17.86% of the participants had a complete secondary school education as compared to 20.43% of the non-participants. For the non-participants, 0.81% of the respondents had a tertiary polytechnic education, 3.76% had a tertiary college education and 1.08% had a university education. None of the participants had a tertiary polytechnic, tertiary college of university education. However, the difference in education level between the participants and non-participants was not significantly different.

The proportion of respondents who had received training on farming and input use was 12.1% and 92.9% for the non-participants and participants respectively as shown in Table 4. This shows that more participants in the *Kilimo Plus* program had been trained unlike the respondents in the non-participants group. The proportion of participants and non-participants who were trained was found to be significantly different at 1%. This shows that a larger proportion of participants in the *Kilimo Plus* program had been trained in comparison to the non-participants.

Table 4: Socioeconomic Characteristics of Sample Households

Variable	Pooled data (Percent)	Percent		χ^2	*Fisher's Exact Test*
		Non-participants n=372	Participants n=28		
Gender of the household head					
Male	80.8	81.2	75.0	0.640	
Female	19.2	18.8	25.0		
Education					
No Education	13	11.56	32.14		
Incomplete primary school education	16.25	15.86	21.43		
Complete primary school education	33.5	34.68	17.86		
Incomplete secondary school education	11.75	11.83	10.71		0.128
Complete secondary school education	20.25	20.43	17.86		
Tertiary polytechnic education	0.75	0.81	0.00		
Tertiary college education	3.50	3.76	0.00		
University education	1.00	1.08	0.00		
Training					
Yes	17.75	12.10	92.86		0.000***
No	82.25	87.90	7.14		
Distance to agro dealer					
< 1km	52.50	53.76	35.71		
1- < 2km	1.25	1.08	3.57		0.051*
2- <4km	36.00	35.75	39.29		
4km and above	10.25	9.41	21.43		
Road to agro dealer					
murram /all weather	62.50	61.56	75.00		
tarmac	20.25	20.43	17.86		0.601
dry weather	7.00	7.26	3.57		
foot path	10.25	10.75	3.57		
Distance to agricultural extension officer					
< 1km	53.75	55.38	32.14		
1- < 2km	0.25	0.27	0.00		0.070*
2- <4km	37.25	36.02	53.57		
4km and above	8.75	8.33	14.29		
Road to extension officer					
murram /all weather	69.75	68.01	92.86		
tarmac	12.50	13.17	3.57		0.040*
dry weather	6.75	6.99	3.57		
foot path	11.00	11.83	0.00		

Source: Survey data, 2013.

Note: Figures in the parentheses are the standard deviation associated with the means. ***P < 0.01, **P < 0.05 and *P < 0.10 mean significant at 1%, 5% and 10% probability levels, respectively

The percentage of farmers within less than 1 kilometre, 1 to 1.9 kilometre, 2 to 4 kilometres and, 4 kilometres and above to the nearest agro dealer and the nearest agricultural extension officer were found to be significantly different at 10% between the participants and non-participants. This showed that the distance the participants in the *Kilimo Plus* program and non-participants had to cover to access these two resources was significantly different. While 53.8% of the non-participants covered less than one kilometre to the nearest agro dealer, only 35.7% of the participants could access an agro dealer in the same distance as shown in Table 4. Additionally, around 55.4% of the non-participants could access an agricultural extension officer in a distance of less than one kilometre while only 32.1% of the participants could access this resource in the same distance. This shows that the non-participants were nearer to an agro dealer and an agricultural extension officer.

About 82.8% of the respondents were connected to an agro dealer via a murram, all weather or tarmac road. In addition, 82.3% of the respondents were connected to an agricultural extension officer via a murram, all weather or tarmac. The results are shown in Table 4. The percentage of participants and non-participants connected to a particular type of to an agricultural extension officer was found to be significantly different at 10%. This is evident as 92.9% of the participants were connected to the agricultural extension officer via a murram or all weather roads while only 68% of the participants were connected through the same type of roads.

About 95.75% of the respondents intended to use fertilizer in the next season as shown in Table 5. This shows a high fertilizer awareness and use rate among smallholder farmers as evidenced by Ariga *et al.* (2008). This also compares well to the study done by Mathenge (2009) where she found out that 71.8% of the households in Kenya with less than one acre use fertilizer and 73.6% of households with one to three acres use fertilizer. About 95.43% and 97.04% of the non-participants were intending to use fertilizer and certified seeds respectively in the subsequent season. This may due to knowledge of the benefits of using fertilizer and certified seeds. Liverpool-Tasie *et al.* (2013) also found that there was a higher use of fertilizer and certified seeds by farmers who were not in the country's subsidy program in Nigeria's Kano due to knowledge of input use.

In the whole sample, 97% were intending to use certified seeds in the next season with only 3% of the respondents intending to use recycled seeds as shown in Table 5. This compares

well with a study done in 2004 by Nyoro *et al.* (2004) that showed that 81.1% of smallholder farmers use of hybrid seeds. When asked what amount of fertilizer the farmers preferred to access, a higher percentage of the participants of the *Kilimo Plus* program preferred to access a higher amount of fertilizer than the non-participants. This represented 78.6% of the participants in the program while only 26.6% of the non-participants preferred to access more than 50 kilograms of fertilizer. The difference in the amount the farmers preferred to access was found to be significantly different between the participants and non-participants at 1%. This shows that the farmers in the *Kilimo Plus* program preferred to use higher rates of fertilizer per acre than the ones who we not in the program. This is in line with the study by Takeshima *et al.* (2012), where it was found out that subsidies lead to a higher fertilizer use rates per acre.

Of the non-participants, 6.45% of the respondents were aware of the *Kilimo Plus* program, how it operates and the benefits accrued from using the inputs as shown in Table 5. Out of the non-participants who were aware of the *Kilimo Plus* program, 2.69% had learnt of the program through the radio, 0.81% from a farmer group, 0.27% from an agricultural officer and 2.69% from a friend or neighbour. This compares to 3.57% of the participants who learnt of the program through the radio, 32.14% from a farmer group, 21.43% from an agricultural officer and 28.57% through a friend or neighbour. Most of the participants leant of the program through their farmer's group (32.1%) and an agricultural extension officer (21.4%). This may have an effect on the quality of information the participants and non-participants have on the program which may in turn affect their perception positively or negatively. The difference in the source of learning about the program was found to be significantly different at 1% between the participants and non-participants.

Table 5: Use of Fertilizer and Certified Seeds and *Kilimo Plus* Program Awareness

Variable	Pooled data (Percent)	Percent		*Fisher's Exact Test*
		Non-participants n=372	Participants n=28	
Future fertilizer use				
Yes	95.75	95.43	100.00	0.621
No	4.25	4.57	0.00	
Future certified seeds use				0.587
Yes	97.00	97.04	96.43	
No	3.00	2.96	3.57	
Preferred fertilizer amount				
< 10kg	9.25	9.95	0.00	
10-19kg	11.00	11.83	0.00	
20-29kg	12.50	13.44	0.00	0.000***
30-39kg	2.50	2.69	0.00	
</= 50kg	34.50	35.48	21.43	
>50kg	30.25	26.61	78.57	
***Kilimo Plus* awareness**				
Yes	13	6.45	100.00	0.000***
No	87.00	93.55	0.00	
Source of learning				
None	87.00	93.55	0.00	
Friend or neighbour	4.50	2.69	28.57	
Group	3.00	0.81	32.14	
Agricultural officer	1.75	0.27	21.43	0.000***
Radio	2.75	2.69	3.57	
Chief baraza	1.00	0.00	14.29	

Source: Survey data, 2013.

Note: ***P < 0.01, **P < 0.05 and *P < 0.10 mean significant at 1%, 5% and 10% probability levels, respectively.

4.2. Perception of the Farmers towards the *Kilimo Plus* Program

The perception of farmer's towards the *Kilimo Plus* program was measured using a Likert-type scale that comprised of five ranks (poor, fair, average, good and excellent). The respondents were asked thirteen questions that related to how they perceived the *Kilimo Plus* subsidy program. The results are shown in Table 6. The thirteen questions were subjected to a reliability analysis using the Cronbach's alpha, which measures whether the questions measure the same variable as suggested by Cronbach (1951). The reliability analysis is shown in

Appendix 2. The Cronbach's alpha was 0.871, meaning that there is 87.1% consistency in the thirteen questions in measuring perception as used by Gliem and Gliem (2003).

Table 6: Likert Scale Results on Perception of Farmers towards the *Kilimo Plus* Program

No.	Perception Question	Percent				
		Poor	Fair	Average	Good	Excellent
1.	The program has helped poor farmers to produce more.	-	7.7	34.6	42.3	15.4
2.	The program has helped poor farmers to pay school fees much easily	3.8	7.7	23.1	55.8	9.6
3.	The program has helped poor farmers to not go hungry.	1.9	1.9	21.2	53.8	21.2
4.	The program has increased farmers income.	1.9	1.9	26.9	59.6	9.6
5.	The program has increased the number of agro dealers in the area.	7.7	11.5	11.5	46.2	23.1
6.	The program has reduced the distance I walk to access fertilizer and seeds.	3.8	5.8	13.5	48.1	28.8
7.	The program has made agricultural officers available.	-	5.8	11.5	44.2	38.5
8.	The program has enabled me to gain knowledge.	1.9	3.8	15.4	38.5	40.4
9.	The program diversified sources of livelihood.	3.8	7.7	25.0	44.2	19.2
10.	The program has enabled me to start saving money.	7.7	7.7	19.2	50.0	15.4
11.	The program has enabled me to open an account. (ANY, bank, group or SACCO)	7.7	5.8	21.2	48.1	17.3
12.	The program enabled me to join/form a farmer group with other beneficiaries.	5.8	3.8	23.1	57.7	9.6
13.	The program is?	-	-	13.5	30.8	55.8

Cronbach's Alpha = 0.871

Source: Survey data, 2013.

The summated rating scale was used to analyse the perception as used by Likert (1932) and suggested by Boone and Boone (2012). Non-parametric tests comprising of the mode and median were used to analyse the perception of the farmers since the responses were categorical. Table 7 shows the results of the analysis of the thirteen questions. The sum was 2,581 and the

mode and median were both 52. This means that the sum lies in between 2028 (3*13*52) and 2704 (4*13*52). Meaning that most of the respondents scored the program as good since the sum is in the good category as shown in Figure 3. But the mode and the median gave an exact category since the ranking were not in a ratio form as suggested by Clason and Dormody (1994). The median and the mode thus show that the respondents ranked the program at rank 4 which is good (4*13=52).

The ranking of the program as good by the farmers shows that they could identify benefits accruing form the program. This shows that the farmers were aware of benefits of being in the *Kilimo Plus* program. This is in line with the study by Druile and Barreiro-Hurle (2012), who found out that subsidy, reduces the lack of knowledge of fertilizer use and benefits. The positive perception of farmers also indicates that given a choice, the farmers would rather be in the *Kilimo Plus* program than not.

The gender of the household head tested against the perception of the respondent towards the *Kilimo Plus* program was found not to be significant. This means that there was no significant difference in perception between the male headed households and the female headed households. Mustafa-Msukwa *et al.* (2011), also found no significant difference between males and females in their perception of compost manure technology.

Table 7: Likert-type Scale Summation, Median and Mode Analysis

Statistic	**Value**
	N=52
Median	52.00
Mode	52.00
Sum	2581.00

Source: Survey data, 2013.

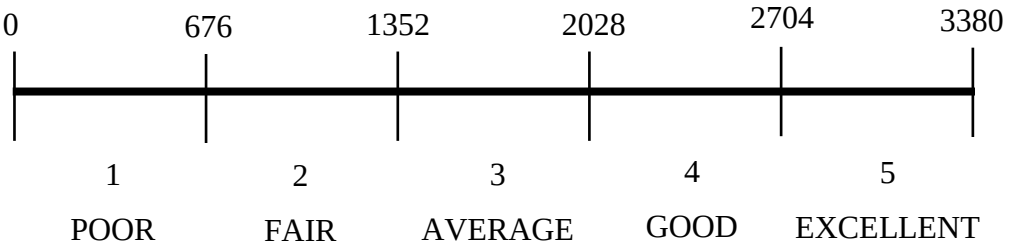

Figure 3: Scale of Farmers' Perception

4.3. Tests for Multicollinearity and Heteroscedasticity

Tests for multicollinearity and heteroscedasticity were done so as to ensure that the statistical tests of significance (*t*-test, *Chi*-square test, Fisher's exact test, Probit) are valid. To test for multicollinearity in dummy variables, the variance-covariance estimator was used to check for correlation between the independent variables. The closer the value are to +1 or -1, the more correlated they are (Taylor, 1990). The absolute values obtained were between 0.0006 and 0.7428 and since they are not above 0.75, there was thus no evidence of strong multicollinearity. The results for the variance-covariance estimator are shown in Appendix 3.

The Variance Inflation Factor (VIF) was used to test for multicollinearity in the continuous variables. Gujarati (2004) defined the Variable Inflation Factor as:

$$\mathrm{VIF}(x_i) = \frac{1}{1 - R_i^2}$$

Where VIF (x_i) is the variance inflation factor for explanatory variable x_i and R_i^2 is the square of the multiple correlation coefficients obtained from regressing x_i on the remaining explanatory variables.

If the Variable Inflation Factor is above 10, then there is multicollinearity. But the values obtained were between 1.01 and 1.08 hence showing no obvious presence of multicollinearity. The results are shown in Appendix 3.

However heteroskedasticity tests were not run due to the nature of the models used in this study. A study done by Williams (2009) found out that heteroskedasticity does not affect the model since the level of overconfidence and coverage rates for a homoskedactic ordered probit and a heteroskedastic ordered probit are close to the ideal and hence give negligible differences. A study by Zhao (2005) also found out that heteroskedastic error terms have little influence on

the estimated treatment effect in propensity score matching. Since these two models were used in this study, there was therefore no need to run heteroskedasticity tested for variables in these two models.

4.4. Factors Influencing the Perception of Smallholder Farmers towards the *Kilimo Plus* Program

The results of an ordered probit regression on perceptions of the farmers towards the *Kilimo Plus* program are presented in Table 8. The model coefficients (cut1 and cut2) were -7.5905 and -5.2217. The log likelihood was -23.0861. Since it was not zero, it means that the model converged therefore meaning that the predictors' regression for the coefficients was not all together equal to zero. The number of observation was 52 respondents. This is because the regression was done conditional on the respondent being aware of the *Kilimo Plus* program. Therefore only 52 respondents were aware of the program. The likelihood ratio (LR) *Chi*-square test was 53.49 with a degree of freedom of 22 (in parenthesis). Since it was not equal to zero, it meant that at least one of the variables' coefficient is not equal to zero. The probability of getting the likelihood ratio (LR) test statistic (Prob > chi2) as extreme than the null hypothesis was 0.0002. Thus, testing at 0.05 (Stata default), then 0.0002<0.05 which leads us to not to accept the null hypothesis that all the regression coefficients in the model are equal to zero. This shows that the model was a good fit and that at least one of the coefficients is not equal to zero. The McFadden's pseudo R-squared (Pseudo R2) was 0.5367. This shows that 53.67% of the variables that influence perception were included in the model.

Out of the twenty two variables used in the model, fourteen were significant. TREATMENT (whether one was in the program or not), MALE (the gender of the household head), respondent being the household head, respondent being a child of the household head, respondent being the parent of the household head and the respondent learning of the *Kilimo Plus* program from the farmer group were found to be significant at 10%. Increase in production, non-farm income, size of the farm, the respondent being a brother or sister in-law of the household head, the respondent having an incomplete primary school education, TRAINING (Training on farming and input use), the respondent learning of the *Kilimo Plus* program from a friend or neighbour and the respondent learning of the *Kilimo Plus* program from the radio were found to be significant at 5%.

Table 8: Ordered Probit Regression Results on Factors Affecting Perception of Farmers towards the *Kilimo Plus* Program

Variable	Coefficient	Marginal effects		
		Average	Good	Excellent
		dy/dx	dy/dx	dy/dx
TREATMENT (whether one was in the program or not)	-3.3632(1.3187)*	0.0016(0.0047)	0.2793(0.2658)	-0.2809(0.2695)
Household size	-0.1796(0.1379)	2.86e-06(0.0000)	0.0074(0.0122)	-0.0074(0.0122)
MALE (Gender of the household head)	-2.4891(1.1305)*	0.0000(0.0001)	0.0541(0.0698)	-0.0541(0.0699)
Age of the household head	0.0071(0.0238)	-1.13e-07(0.0000)	-0.0003(0.0011)	0.0003(0.0011)
Increase in production	1.5105(0.4753)**	-0.0000(0.0001)	-0.0620(0.0862)	0.0620(0.0863)
Farm income	0.0000(0.0001)	-5.80e-10(0.0000)	-1.50e-06(0.0000)	1.50e-06(0.0000)
Non-farm income	0.0004(0.0001)**	-5.83e-09(0.0000)	-0.0000(0.0000)	0.0000(0.00000)
Size of the farm	-1.7556(0.6474)**	0.0000(0.0001)	0.0721(0.1024)	-0.0721(0.1025)
Household head	-4.8692(2.1357)*	0.0791(0.1858)	0.7517(0.1709)***	-0.8308(0.3154)**
Spouse to the household head	-2.3770(1.5299)	0.0025(0.0091)	0.3247(0.3960)	-0.3272(0.4039)
Child to the household head	4.4367(2.3262)*	-0.0000(0.0001)	-0.0366(0.0549)	0.0366(0.0550)
Parent of the house hold head	3.8953(1.9729)*	-0.0000(0.0001)	-0.0462(0.0656)	0.0462(0.0657)
Niece to the household head	-0.4759(2.1309)	0.0000(0.0003)	0.0318(0.2122)	-0.0318(0.2124)
Brother or sister in-law to the house hold head	-7.2057(2.7168)**	0.9924(0.0460)***	-0.0002(0.0422)	-0.9920(0.0170)***
Incomplete primary school education	-2.9669(1.0529)**	0.0153(0.0361)	0.5638(0.3090)*	-0.5791(0.3369)*
Complete primary school education	0.1658(0.8020)	-2.11e-06(0.0000)	-0.0061(0.0274)	0.0061(0.0274)

Table 8: Continuation

Variable	Coefficient	Marginal effects		
		Average	Good	Excellent
		dy/dx	dy/dx	dy/dx
Incomplete secondary school education	0.7405(1.4151)	-4.59e-06(0.0000)	-0.0171(0.0331)	0.0171(0.0331)
Complete secondary school education	-2.1694(1.4683)	0.0018(0.0070)	0.2871(0.3860)	-0.2889(0.3921)
TRAINING (Training on farming and input use)	4.7811(1.6507)**	-0.0595(0.1119)	-0.7315(0.1948)***	0.7909(0.2751)**
Learnt of the program from a friend or neighbour	-3.7149(1.2355)**	0.0191(0.0419)	0.5972(0.2989)*	-0.6163(0.3307)*
Learnt of the program from a farmer group	-2.0509(0.9493)*	0.0017(0.0058)	0.2832(0.3048)	-0.2849(0.3096)
Learnt of the program from the radio)	-5.3492(1.8778)**	0.3884(0.5164)	0.5927(0.4577)	-0.9809(0.0652)***
cut1				-7.5905(2.5143)
cut2				-5.2217(2.3347)
Log likelihood				-23.0861
Number of observation				52
LR chi2(22)				53.49
Prob > chi2				0.0002
Pseudo R2				0.5367

Source: Survey data, 2013.

Note: Figures in the parentheses are the standard errors associated with the coefficients and marginal effects. ***P < 0.01, **P < 0.05 and *P < 0.10 mean significant at 1%, 5% and 10% probability levels, respectively.

The ordered probit coefficients give the predicted probability. Therefore the coefficients cannot be interpreted directly without further calculation as suggested by Greene (2002) and Hogarth and Anguelov (2004). Therefore, in order to know the amount of change in perception due to a unit change in the explanatory variable, marginal effects are used. Marginal effects are calculated by taking means of all the other explanatory variables. A negative value shows that an increase in the explanatory variable reduces the probability that perception will be in that specific category reduces while a positive value increases the probability that it will be in that category. The marginal effects results are presented in Table 8.

The results show that if the perception is average or good, a unit change in TREATMENT (whether one was in the program or not) increases the probability of the farmer's perception being average and good by 0.0016 and 0.2793 respectively if all the other factors are held constant at the mean. On the other hand, if all factors are constant at the mean, if the perception is excellent, a unit change in TREATMENT reduces the chance that perception is excellent by 0.2809. This may be explained by the groups' dynamics in the farmer groups that led to their collapse. Forming farmer groups was a precondition to accessing the subsidized inputs. Thus, the groups were not formed on the farmers' own initiative. Research done by Davis *et al.* (2004) found out that farmer groups that were not formed by farmers on their own not only affected the groups' cohesiveness but also their perception of the group and their activities. Thus this may have led to the farmers in the program to rank the program as average or good rather than excellent. In addition, participants in the high altitude areas (Dundori) also complained of being given the wrong seed which may have contributed to the farmers' perception. This is because the smallholder farmers are the consumers of the *Kilimo Plus* subsidy program inputs. Therefore, their preference in characteristics of the inputs affects their perception. In this case, the type of maize seed was not what the farmers preferred and thus affected their perception negatively

A unit change in the household head being a male raises the probability that perception is average by 0.0000 while it increases the probability that perception is good by 0.0541 and reduces the probability that perception is excellent by the same value *ceteris paribus*. This shows that the male household heads were less likely to rank the program as excellent as compared to the female household head. A unit change in production reduces the chance of a farmer's

perception being average by 0.000, the chance that perception is good by 0.0620 and increases the probability that perception is excellent by 0.0620 when all the other variables are held constant at the mean.

When all factors are held constant, a unit change in non-farm income reduces the probability that a farmer's perception being average by $5.83e^{-09}$, the probability that perception is good by 0.0000 while it increases the probability that perception is excellent by and 0.0000. This shows that a person who had non-farm income was more likely to perceive the program as excellent. Most smallholder farmers' farm and non-farm income are usually integrated. Thus, an increase in non-farm income is geared towards increasing the farm income since farming is the households' primary activity as suggested by Mishra and Goodwin (1997). Therefore, since the program increases the income of the farm through inputs, the farmers' who had a non-farm income would perceive the program as excellent.

A unit change in the farm size increases the probability that perception is average and good by 0.0000 and 0.0721 respectively while reducing the probability that perception is excellent by 0.0721 *ceteris paribus*. Thus, on the basis of farm size, farmers were more likely to perceive the program as average or good rather than excellent. Taking into consideration that the average land size for the sample is 1.38 acres then, farm size acts as a limitation to the farmers to produce more despite the program's initiative. A study done by Chand *et al.* (2011) found out that small farms are more productive but inadequate in generating income and sustaining livelihood. The study also found out that land holding below 1.98 acres is inadequate to keep a farm family out of poverty despite high productivity if the farm is their only source of income. Shiferaw and Holden (1998) also found out that the size of cultivatable land per capita affects perception of farmers negatively.

The respondent being the household head increases the probability that perception is average by 0.0791 and that it is good by 0.7517 while it reduces the chance that perception is excellent by 0.8308. The respondent being a child to the household head or a parent of the household head decreases the probability of perception being average by 0.0000 and reduces the probability of the perception being good by 0.0366 and 0.0462 respectively while it increase the perception being excellent by 0.0366 and 0.0462 respectively when all the other factors are constant. This shows that if the respondent was a child or parent of the household head, then they

were more likely to perceive the *Kilimo Plus* program as excellent. This may be explained by the direct welfare benefits that a child or parent to the household head accrues from a participant of the program. A study by Breunig and Dasgupta (2003) found that there is a direct welfare effect between the household income and the welfare of the children and elderly dependents such as parents. As a consequence, the child or parent would advocate for programs such as the *Kilimo Plus* program due to the welfare that may emanate from the program. The respondent being a brother or sister in-law to the household head increases the probability that perception is average by 0.9924 while decreasing the chance that perception is good or excellent by 0.0002 and 0.9920 respectively.

A unit change in incomplete primary school education increases the probability that perception is average or good by 0.0153 and 0.5638 respectively while it reduces the probability that perception is excellent by 0.5791. This shows that the respondents who had an incomplete primary school education were more likely to rank the program as average or good instead of excellent. The level of education affects the willingness of an individual to learning and use of new methods and techniques as put forward by Adeogun *et al.* (2010). Since the programs activities included training on farming and inputs use, this may have influenced the perception of the farmers who had an incomplete primary school education as to rank it as average or good rather than excellent.

A unit change in training on farming and input use decreases the probability that perception is average or good by 0.0595 and 0.7315 respectively while it increases the probability that perception is excellent by 0.7909. This shows that if farmers had been trained on input use, then they were likely to perceive the program as excellent. Nigeria (2010), found out that training brought about a change in attitude of farmers leading to a good perception. This finding is also consistent with the study done by Yadav *et al.* (2011) that found out that farmers who had a high perception of organic farming increased from 7.5% to 26.67% after training.

If the respondent learnt of the *Kilimo Plus* program from a friend or neighbour, farmer group or radio increases the probability that perception is average by 0.0191, 0.0017 and 0.3884 respectively, increases the chance that perception is good by 0.5972, 0.2832 and 0.5927 respectively while it decreases the probability that perception is excellent by 0.6163, 0.2849 and 0.9809 respectively. Thus farmers who had gotten information of the *Kilimo Plus* program

through a friend or neighbour, farmers group or radio were less likely to rank the program as excellent. Research done by Alfred and Fagbenro (2007) in Nigeria that showed the radio was the most effective way of communication to tilapia farmers as a source of information. Alfred and Fagbenro (2007) also found out that friends as a source of information was the most affordable. However the difference in the findings can be attributed to the nature of research. In the case of Alfred and Fagbenro (2007), the Likert scale asked the frequency of use and the effectiveness was measured by the level of farmer satisfaction while in this study, the farmer was asked of how they learnt of the *Kilimo Plus* program and no inference of effectiveness was derived from the answer. Radio as a source of information also depends with the language that is used. Radio is more effective as a source of information when it is in the farmers' language. Since the *Kilimo Plus* program is a government program, the information relayed on the radio is in the official languages. This may have resulted to a problem of language barrier especially to the unlearned population as found out by Agwu and Adeniran (2010), and thus leading to the farmers perceiving the program as average or good rather than excellent. The negative coefficient in the farmers who learnt of the program from a farmer group can be associated with the negative perception created in the farmers because of the collapse of the groups.

4.6. Algorithm to Estimate the Propensity Score

Farmers who were selected to be in the *Kilimo Plus* program were ones who were vulnerable, resource poor and had at least an acre of land where they could plant maize. As such, variables that represent these administrative rules were used in the matching techniques since they are observable characteristics and thus provide a good basis of matching those in the program and those without.

Age was selected because the aged have been known to be more vulnerable to poor quality life, disease and death (Grundy 2006). Thus, this makes the family that is headed by an elderly person more vulnerable. Household size was also used as an observable characteristic to match on because it not only determines the level and source of income but also the wealth of the household as suggested by El-Osta *et al*. (2002). The gender of the household head was also included as a measure of vulnerability. Ligon and Schechter (2003), found out that female headed households are more susceptible to shocks than male headed households. Gangopadhyay and Wadhwa (2004) also found out that female headed households are more vulnerable to

poverty than male headed households due to less education and land holding. Education was also used in matching because it not only influences wealth and income as put forward by Filmer (1999) and Card (1999), but income and wealth also influences education level as advocated by Filmer and Pritchett (1999), Filmer and Pritchett (2001) and Glewwe and Jacoby (2004). Farm size was used in the matching not only because it was one of the administrative rules, but it is also used as proxy for wealth as employed by Araral (2009).

The results discussed below used the stratification matching approach although the kernel matching results are also shown in Appendix 4 so as to show the model's robustness. The stratification method partitions the common support of the propensity score into strata and calculates the impact within individual strata by taking the mean difference in outcomes between the participants and non-participants. The approach was chosen over the kernel, radius and nearest neighbour approaches because by comparing respondents in the same strata, it makes the difference more precise since the difference in the observable characteristics other than treatment is reduced.

To calculate the propensity score, a probit model was used where the treatment variable was regressed against the age of the household head, the household size, the gender of the household head, education level of the household head (no education, incomplete primary school education, complete primary school education, incomplete secondary school education, and complete secondary school education) and the farm size. The results for the regression are presented in Table 9. The number of observations was 400 respondents. The likelihood ratio (LR) *Chi*-square test was 30.56 with a degree of freedom of 9 (in parenthesis). Since it was not equal to zero, it meant that at least one of the variables' coefficient is not equal to zero. The probability of getting the likelihood ratio (LR) test statistic (Prob > chi2) as extreme than the null hypothesis was 0.0004. Thus testing at 0.05 (Stata default), then $0.0004<0.05$ which leads us to not to accept the null hypothesis that all the regression coefficients in the model are equal to zero thus showing that the model was a good fit and that at least one of the coefficients is not equal to zero. The McFadden's pseudo R-squared (Pseudo R2) was 0.1506.The log likelihood was -86.176. Since it was not zero, it means that the model converged therefore meaning that the predictors' regression for the coefficients was not all together equal to zero. However, it is

important to note that the McFadden's pseudo R-squared is not of importance in this model since the aim of the model is to produce the propensity score that ranges between 0 and 1.

Table 9: Probit Regression for Calculating the Propensity Scores

TREATMENT	Coefficients	Standard Errors	Z
Age	0.0110	0.0071	1.5400
Household size	-0.2214	0.0608	-3.6400***
Male	0.0058	0.2541	0.0200
No education	5.2597	0.6183	8.5100***
Incomplete primary education	5.0049	0.5944	8.4200***
Complete primary education	4.5110	0.5448	8.2800***
Incomplete secondary education	4.8338	0.5612	8.6100***
Complete secondary education	4.8016	0.5442	8.8200***
Farm size	-0.0499	0.1440	-0.3500
_cons	-5.4989		
N	400		
LR chi2(9)	30.5600		
Prob > chi2	0.0004		
Pseudo R2	0.1506		
log likelihood	-86.1760		

Source: Survey data, 2013.

Note: ***P<0.01, **P<0.05 and *P< 0.10 means significant at the 1%, 5% and 10% probability levels, respectively.

The common support region was between 0.0092 and 0.3976. This means that the highest propensity score was 0.3976 while the lowest was 0.0092. The mean propensity score was 0.0798. This means that the probability for a respondent in the sample to be in the *Kilimo Plus* program was 7.98%. The estimated propensity score and the regions of common support are shown in Table 10.

Table 10: Description of the Estimated Propensity Score in Region of Common Support

Percent	Percentiles	Propensity Scores
		Smallest
1	0.0097	0.009203
5	0.0136	0.0092498
10	0.0190	0.0095747
25	0.0298	0.0097421
50	0.0514	
		Largest
75	0.1058	0.3185176
90	0.1836	0.3552043
95	0.2415	0.3953155
99	0.3185	0.3975913
Observations	341	
Sum of Weight	341	
Mean	0.0798	
Std. Dev.	0.0724	
Variance	0.0052	

Source: Survey data, 2013.

The number of blocks estimated was five. This is of importance to the analysis since these blocks will be used as the basis for stratification. Five strata were used in stratification matching. The five strata generated are also sufficient for removing any bias associated with the covariates. Cochrane and Chambers (1965) showed that having five strata removes 95% of the bias associated with one single covariate while Imbens (2004) found out that five strata removes most of the bias associated with all covariates. Thus the five blocks generated also improves the results. The five strata also were used in balancing in order to satisfy the balancing property of propensity score. The value of the propensity score in each stratum (inferior bound) and the distribution of the participants and non-participants in each stratum are shown in Table 11.

Table 11: Inferior Bound, Number of Participants and the Number of Non-participants for Each Block

Inferior of block of propensity score	Participation Variable		Total
	Non-participants	Participants	
0.0092	240	10	250
0.1000	32	9	41
0.1500	21	1	22
0.2000	18	4	22
0.3000	2	4	6
Total	313	28	341

Source: Survey data, 2013.

4.7. To determine the impact of the *Kilimo Plus* program on food security of smallholder farmers households

To determine the food security of the farmers, two instruments were used; the dietary diversity and food insecurity perception. The dietary diversity questionnaire was used that comprises of sixteen questions. The questions were aggregated into twelve food groups to create the household dietary diversity score (HDDS) as suggested by Coates *et al.* (2007). The individual scores reflect the nutritional quality of the diet while HDDS indicates the household economic access to food as advocated by FAO (2007). The twelve food groups are presented in Table 12.

Each of the food groups was given a value of one thus giving a range of 0-12 for all the scores. Since there is no established cut-off point to indicate adequate of inadequate dietary diversity, the distribution of scores was thus used for analytical purposes as suggested by FAO (2007) guidelines.

Table 12: Aggregation of Food Groups from the Questionnaire to Create HDDS

Question Number(s)	Food Group
1	Cereals
2	White tubers and roots
3,4,5	Vegetables
6,7	Fruits
8,9	Meat
10	Eggs
11	Fish and other seafood
12	Legumes, nuts and seeds
13	Milk and milk products
14	Oils and fats
15	Sweets
16	Spices, condiments and beverages

Source: Food and Agriculture Organization (FAO) (2007).

The scores were thus input into the propensity score matching model to see the effect of the *Kilimo Plus* program on the farmer's food security. The average treatment effects on the treated (ATT) results of the HDDS matching done through the stratification method are shown in Table 13 while the bootstrapped standard errors results are shown in Appendix 4.

Table 13: HDDS Average Treatment Effects on the Treated (Stratification Matching) Results

Participants	Non-participants	ATT	S.E.	*t*
28	313	1.406	0.3760	3.737

Source: Survey data, 2013.

The participants were matched to 313 non-participants. The *t*-statistic is greater than two thus showing that there was a significant difference between the participants and non-participants.

The results show that the respondents in the *Kilimo Plus* program had a higher dietary diversity score of 1.406. This thus shows that being in the *Kilimo Plus* program enabled the farmers to have a more diverse diet in comparison to the farmers who were not in the program.

But since there is no fixed level of adequate or inadequate dietary diversity level, the food insecurity perception was also used to determine the food security level of the farmers and thus substantiate the HDDS results. The food insecurity perception comprises of fifteen questions and the food security level categories are ranked according to the number of questions answered as suggested by Correa (2007). A person is food secure if they answer all the questions negatively, at the light food insecurity level if they answer between one to five questions positively, at moderate food insecurity level if they answer between six and ten of the questions positively and at serious food insecurity if they answer between eleven and fifteen questions positively.

For analysis purposes since the propensity score matching method uses continuous data, the food insecurity perception responses were used to generate the food security perception score with a range between 0-15. Following the ranking by Correa (2007), if a respondent has a score of 15, then they are food secure, if they have a score of 10 to 14, they are at light food insecurity level, if the score is between 5 and 9, they are at moderate food insecurity level and if the score is between 0 and 4, then they are at serious food insecurity level. Table 14 shows the food security levels between the participants and non-participants of the *Kilimo Plus* program.

Table 14: Food Security Levels using Food Insecurity Perception

Food Security Level	**Food Security Score**	**Frequency** N = 400		**Fisher's Exact Test**
		Participants	Non-participants	
Food Secure	15	23	8	
Light Food Insecurity	10-14	1	117	0.000***
Moderate Food Insecurity	5-9	3	107	
Serious Food Insecurity	0-4	1	140	

Source: Survey data, 2013.

Note: ***P<0.01, **P<0.05 and *P< 0.10 means significant at the 1%, 5% and 10% probability levels, respectively.

The results show that the differences in the food security levels were significantly different between the farmers who were in the *Kilimo Plus* program and those who were not at 1%. This shows that there are differences in the food security levels between the participants and non-participants. But in order to know the effect that the program had on their food security through matching, the difference between the participants and non-participants should not be significant. Thus the propensity score matching approach was used to match the participants and non-participants using the food security perception scores. The results are shown in Table 15 and the bootstrapped standard errors results in Appendix 4.

Table 15: Food Security Perception Score Average Treatment Effects on the Treated (Stratification Matching) Results

Participants	**Non-participants**	**ATT**	**S.E.**	***t***
28	313	6.816	0.758	8.989

Source: Survey data, 2013.

The results show that there was a significant difference between the twenty eight participants and three hundred and thirteen non-participants. This shows that there was a significant difference between the participants and non-participants in the *Kilimo Plus* program since the *t*-statistic is greater than two.

Therefore, the farmers who were in the *Kilimo Plus* program had a higher food security perception score of 6.816 than farmers who were not in the program. The ATT value of 6.816 is very noteworthy to the study since it is greater than 5. This is because if a respondent had an absolute food security perception score of 5, this would make the respondent to move from a lower food security level to a higher level or vice versa. Since 6.816 is positive, then it means the *Kilimo Plus* program shifted the food security level of the farmers in the program from a lower level to a higher level. Consequently, by the results of the HDDS and the food insecurity perception, we can conclude that the *Kilimo Plus* program had improved the food security level of the farmers in the program.

The results of the impact of the *Kilimo Plus* subsidy on food security are in line with the findings of Chirwa *et al.* (2011) where the study found a positive relationship between access to

subsidy and food consumption in Malawi. The study concludes that there is a positive trend in food security outcomes as households access the subsidy. The 1.406 increase in dietary diversity score for farmers in the *Kilimo Plus* program shows an increase in food access for the farmers in the *Kilimo Plus* program since the dietary diversity score also measures a household's ability to access food. This finding concurs with the finding of Chirwa *et al.* (2011) who found out that households in the Malawi subsidy program consumed more maize, vegetables and meat products in comparison to non-recipients of the subsidy. Holden and Lunduka (2010b) also found out that the smart subsidy in Malawi significantly improves household food security with 66.1% of the respondents citing improved food security on the household and 68.9% of the respondents citing improved food security at the community level.

4.8. Impact of the *Kilimo Plus* on the Income of Smallholder Farmers

In order to determine the effect of the *Kilimo Plus* program on the income of smallholder farmers, the total income (farm and non-farm) were adjusted in accordance to the household size and composition. The mean adjusted household size for the respondents in the *Kilimo Plus* program was 2.3149 while the mean for the non-recipients of the subsidy was 2.6605. A *t*-test was done to find out if there was significant difference between the adjusted household size of the participants and non-participants. The t-value was 3.823 and it was significant at 1%. This shows that there was significant difference in the means of the adjusted household size, with the non-participants having a higher adjusted household size than the participants.

The mean adjusted household income for the non-participants was Kshs. 1,969.56 while the adjusted household income of the participants in the *Kilimo Plus* program was Kshs. 1,848.73. The t-value was 0.145 but there was no significant difference between the two means of adjusted income between the recipients and non-recipients of the subsidy. Table 16 shows the *t*-test results.

Table 16: *t*-test on Adjusted Household Size and Income

Variable	Mean		t-value
	N= 400		
	Non-participants	Participants	
	n = 372	n = 28	
Adjusted Household size	2.6605	2.3149	3.823***
Adjusted income	1969.5644	1848.7290	0.145

Source: Survey data, 2013.

Note: ***P<0.01, **P<0.05 and *P< 0.10 means significant at the 1%, 5% and 10% probability levels, respectively.

To ascertain the impacts of the subsidy on the farmers' income, the ADJPERINC (adjusted household income) was input into the propensity score model and matched using the stratification approach. The results are shown in Table 17 and the bootstrapped standard errors results in Appendix 4.

Table 17: Income Average Treatment Effects on the Treated (Stratification Matching) Results

Participants	**Non-participants**	**ATT**	**S.E.**	***t***
28	313	403.503	91.191	4.425

Source: Survey data, 2013.

The t-statistic was greater than two hence showing that there was a significant difference between the participants and non-participants after matching. The results indicate that the *Kilimo Plus* program had a positive effect on the famers who were in the program with the farmers having an additional monthly income of Kshs. 403.50.

The findings concur with the findings of a study done by Chirwa (2010). The study found that the 2006/07 Agricultural Input Subsidy Program increased the income of farmers by 1,567 to 1,705 Malawian Kwacha using the average treatment effect on the treated (ATT) approach. The finding of this study is also in line with Dorward (2010) and Dorward and Chirwa (2011) who also found an increase in the real incomes of farmers who benefited from the subsidy in Malawi.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary and Conclusions

The aim of this study was to assess the impact of the *Kilimo Plus* program on smallholders' food security and income. The descriptive statistics showed that the land holding in the district is small with farmers owning less than one hectare. The average household size was six persons per household which is close to the country's average of 5 persons per household. A majority of the households in the district are headed by males with only nineteen percent of the households being headed by females. The literacy rate in the district is also high with 87% of the respondents being literate. The road network in the district is fairly good with 82.8% and 82.3% of the respondents connected via a murram, all weather or tarmac road to an agro dealer and agricultural extension officer respectively. Penetration of fertilizer and certified seeds was also high in the district with 95.4% of the respondents intending to use fertilizer in and 97% intending to use certified seeds the subsequent season. The respondents in the *Kilimo Plus* subsidy program also preferred to buy a larger amount of fertilizer than the available package of 50 kilograms.

The results showed that the farmers ranked the *Kilimo Plus* program as good which is a positive perception. The positive perception of the program indicates that the farmers perceived the program as beneficial and also shows an increase in the knowledge of the benefits of fertilizer and certified seeds. Therefore, farmers will have a positive perception of a subsidy program that they deem as beneficial.

The gender of the household head being male, farm size, being in the *Kilimo Plus* program, being the household head, having an incomplete primary school education and learning of the *Kilimo Plus* program through a friend or neighbour, farmer group and the radio, were found to influence the perception of the farmer negatively. While increase in production and training on farming and inputs use influenced the farmer's perception positively. The study also concludes that the relationship of the respondent to the household head determines their perception of the *Kilimo Plus* program. This was deduced by the fact that being a niece of the household head, brother or sister in law of household head influenced perception negatively

while being a child to the household head or being a parent of the household head influenced perception positively.

The effect of the program on the food security of the smallholder farmers was positive with the propensity score matching analysis recording an increase in the participants' dietary diversity score and food security perception score. The analysis showed an increase of 1.406 in the dietary diversity score and 6.816 in food security perception score. An increase in the food security perception score by five points, makes a respondent to move from one food security level to the next. The study thus concludes that the *Kilimo Plus* program enabled the famers to move from serious food insecurity to moderate food insecurity, moderate food insecurity to light food insecurity or from light food insecurity to being food secure.

The *Kilimo Plus* subsidy program also had a positive effect on the smallholder farmers by increasing their income. A propensity score matching analysis of the income of the smallholder farmers in the program indicated an increase in the monthly income for the participants. This means that the farmers who were in the program were getting a higher income per month as compared to those who were not in the program.

5.2 Recommendations

The results showed that even though the farmers had a positive perception of the *Kilimo Plus* program. Such program implementation challenges as group collapse, late supply of inputs and provision of wrong seeds resulted to some farmers perceiving the program negatively. Hence there is need for the government to make sure that the farmers perceive these inputs as beneficial. In order to achieve this, the government needs to educate the farmers who were affected negatively by the program because of receipt of wrong seeds on the importance of using fertilizer and seeds and if possible roll out the program once more while being careful of the seeds they supply.

The study also found out that the male household head perceived the program negatively and hence the government needs to address this to ensure that the resource poor male headed households do not shun such programs since they are more economically vulnerable and thus the target population of such subsidy programs as *Kilimo Plus*. This may necessitate the formulation

of subsidy programs whose training is flexible and appealing to the male household heads' schedule and that does not overburden them through increasing activities.

The study also found out that the subsidy was given for only two years after which it was terminated in the district. I would therefore advise the government to make the subsidy program continuous so as to ensure a real welfare improvement of the targeted population. Although the results show a positive effect, granting the subsidy to a poor farmer for one year or two then discontinuing the program may only have short-term effects. I therefore suggest to the government to make sure that the training, and subsidized inputs are given continuously to the farmers in order to achieve the targeted goal of raising the poor farmers' income and food security in the long run.

The study also found out that in the study area, the targeted crop was maize. Even though maize is the stable food in Kenya, there is also need for the government to formulate subsidy programs that encourage the farmers to diversify their farming practices especially with regards to indigenous and drought resistant food crops. This is of particular importance to the country in the face of the climate variability and change challenges that it faces especially in regards to erratic rainfall and unpredictable seasons.

5.3 Area of Further Research

There is need for further research in the effects of the *Kilimo Plus* program on the smallholder farmers especially in isolating the unobservable characteristics such as sale of inputs by the farmers and use of fertilizer on other crops. This necessitates the use of higher econometric models that will exclude the effects of unobservable factors so as to ascertain the effects that accrue from the subsidy program.

REFERENCES

Adeogun, S. O., Olawoye, J. E., and Akinbile, L. A. (2010). Information Sources to Cocoa Farmers on Cocoa Rehabilitation Techniques (CRTs) in Selected States of Nigeria. *Journal Media and Communication Studies*, 2(1), 009-015.

African Union (AU). (2006). Abuja Declaration on Fertilizer for an African Green Revolution. Abuja. Nigeria. 13 June 2006.

Agwu, A. E., and A. A. Adeniran. (2010). Sources of Agricultural Information Used by Arable Crop Farmers in Isale Osun Farm Settlement, Osogbo Local Government Area of Osun State. *Journal of Agricultural Extension*, 13(1).

Alexandratos, N., and Bruinsma, J. (2012). *World agriculture towards 2030/2050: the 2012 revision* (No. 12-03). ESA Working paper.

Alfred, S. Y., and O. A. Fagbenro. (2007). Perception of Tilapia Farmers on Information Sources in the Coastal Region of Ondo State, Nigeria. *Age*, 97(23), 80-84.

Angrist, J., Bettinger, E., Bloom, E., King, E., and Kremer, M. (2001). *Vouchers for private schooling in Colombia: Evidence from a randomized natural experiment* (No. w8343). National Bureau of Economic Research.

Araral, E. (2009). What Explains Collective Action in the Commons? Theory and Evidence from the Philippines. *World development*, 37(3), 687-697.

Ariga, J., Jayne, T.S., Kibaara B. and Nyoro, J.K. (2008). Trends and Patterns in Fertilizer Use by Smallholder Farmers in Kenya, 1997-2007. Tegemeo Working Paper No.32: Tegemeo Institute, Egerton University. Nairobi.

Awotide, B. A., Awoyemi, T. T., Diagne, A., and Ojehomon, V. T. (2011). Impact Of Access To Subsidized Certified Improved Rice Seed On Income: Evidence From Rice Farming Households In Nigeria. *OIDA International Journal of Sustainable Development*, *2*(12).

Baltzer, K. T., and H. Hansen. (2011). Agricultural input subsidies in Sub-Saharan Africa. Ministry of Foreign Affairs of Denmark. Danida.

Banful, A.B. (2011). Old problems in the new solutions? Politically motivated allocation of program benefits and the "new" fertilizer subsidies. *World Development*, 39(7), 1166–1176.

Barahona, C. (2010). Randomised Control Trials for the impact evaluation of development initiatives: a statistician's point of view. *Institutional Learning and Change Working Paper 13*.

Barrios, S., Bertinelli, L. and Strobl E. (2006). Climatic change and rural–urban migration: The case of sub-Saharan Africa. *Journal of Urban Economics*, 60(2006), 357–371.

Baser, O. (2006). Too much ado about propensity score models? Comparing methods of propensity score matching. *Value in Health*, 9(6), 377-385.

Binswanger, H.P., and P. Pingali. (1988). Technological priorities for farming in sub-Saharan Africa. *The World Bank Research Observer,* 3(1), 81-98.

Black K. (2004). *Business Statistics for Contemporary Decision Making*. Wiley Student Edition for India. Fourth ed. Wiley-India.

Boone, H. N., and Boone, D. A. (2012). Analyzing Likert Data. *Journal of Extension*, *50*(2), 2TOT2.

Bower, K. M. (2003a). The Two-Sample *t-test* and Randomization Test. Six Sigma Forum, June 13, 2003.

Bower, K. M. (2003b). When to use Fisher's exact test. *American Society for Quality, Six Sigma Forum Magazine*, 2(4), 35-37).

Breunig, R., and I. Dasgupta. (2003). Welfare Transfers and Intrahousehold Trickledown: A Model with Evidence from the US Food Stamp Program. Center for Research in Economic Development and International Trade, Discussion Paper No. 469. October 2003.

Busk, P.L. (2005). Cross-sectional Design. In B. Everitt and D.C. Howell (Eds.), *Encyclopedia of statistics in Behavioral Science*. Chichester, UK: John Wiley and Sons.

Caliendo M. and S Kopeinig. (2008). Some Practical Guidance for the Implementation of Propensity Score Matching. *Journal of Economic Surveys*, 22(1), 31-72.

Card, D. (1999). The causal effect of education on earnings. *Handbook of labor economics*, *3*(1), 1801-1863.

Casaburi, L., Glennerster, R., and Suri, T. (2012). *Rural Roads and Intermediated Trade: Regression Discontinuity Evidence from Sierra Leone*. MIT Sloan mimeo.

Caviglia-Harris J. L. (2003). Sustainable Agricultural Practices in Rondônia, Brazil: Do Local Farmer Organizations Affect Adoption Rates? *Economic Development and Cultural Change*, 52(1), 23-49.

Chand, R., Prasanna P. A. L. and Singh A. (2011): Farm Size and Productivity: Understanding the Strengths of Smallholders and Improving Their Livelihoods. *Economic and Political Weekly*, 46 (26/27), 5-11.

Chibwana, C., Jumbe, C. B., and Shively, G. (2013). Agricultural subsidies and forest clearing in Malawi. *Environmental Conservation*, 40(01), 60-70.

Chibwana, C., M. Fisher and Shively G. (2011). Cropland Allocation Effects of Agricultural Input Subsidies in Malawi. *World Development* 40(1), 124-133.

Chirwa, E. W., Matita, M. M., Mvula, P. M., and Dorward, A. (2011). Impacts of the Farm Input Subsidy Programme in Malawi. Paper prepared for Malawi Government / DFID Evaluation of Malawi Farm Input Subsidy Programme, School of Oriental and African Studies, University of London.

Chirwa, T. G. (2010) Program Evaluation of Agricultural Input Subsidies in Malawi using Treatment Effects: Methods and Practicability based on Propensity Scores. MPRA Paper No. 20878.

Clason, D. L. and T. J. Dormody. (1994). Analyzing data measured by individual Likert-type items. *Journal of Agricultural Education*, 35(4), 31-35.

Coates, J., Swindale A. and Bilinsky P. (2007). Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3). Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development, August 2007.

Cochrane, W., and S. Chambers. (1965). The Planning of Observational Studies of Human Populations. *Journal of the Royal Statistical Society. Series A (General).* 128(2), 234-266.

Cronbach L.J. (1951). "Coefficient alpha and the internal structure of tests". *Psychometrika*, 16(3), 297–334.

D'Antoni, J. M., Mishra, A. K., Powell R. and Martin S. (2012). Farmers' Perception of Precision Technology: The Case of Autosteer Adoption by Cotton Farmers. Selected

Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meeting, Birmingham, AL, February 4-7, 2012.

Datta, G. and T. Meerman. (1980). Household Income or Household Per Capita in Welfare Comparisons, World Bank Staff Working Paper No. 378.

Davis, K., Franzel, S., Hildebrand, P., Irani, T., and Place, N. (2004). Extending technologies among small-scale farmers in Meru, Kenya: ingredients for success in farmer groups. *The Journal of agricultural education and extension*, 10(2), 53-62.

Donald, S. G., and Lang, K. (2007). Inference with difference-in-differences and other panel data. *The review of Economics and Statistics*, *89*(2), 221-233.

Dorward A. (2009). Rethinking agricultural input subsidy programmes in a changing world. Paper prepared for the Trade and Markets Division, Food and Agriculture Organization of the United Nations.

Dorward, A. (2010). Informal Rural Economy Modelling of Subsidy Impacts. Work in progress, School of Oriental and African Studies, London.

Dorward, A. and E. Chirwa. (2011). The Malawi Agricultural Input Subsidy Programme: 2005–06 to 2008–09. *International Journal of Agricultural Sustainability*, 9(1), 232–247.

Dorward, A., Chirwa, E., Boughton, D., Crawford, E., Jayne, T., Slater, R., Kelly V., and Tsoka M. (2008). Towards 'smart' subsidies in agriculture? Lessons from recent experience in Malawi. Overseas Development Institute, September 2008.

Druilhe Z. and J. Barreiro-Hurlé. (2012). Fertilizer subsidies in sub-Saharan Africa.ESA Working paper No. 12-04. Agricultural Development Economics Division. Food and Agriculture Organization of the United Nations.

Duflo, E., Kremer, M. and Robinson, J. (2009). Nudging farmers to use fertilizer: theory and experimental evidence from Kenya. NBER Working Paper No. 15131.

DuGoff, E. H., Schuler, M., and Stuart, E. A. (2013). Generalizing Observational Study Results: Applying Propensity Score Methods to Complex Surveys. *Health services research*.

Duncan, C.S., Khattak, A.J., and Council, F.M. (1998). Applying the ordered probit model to injury severity in truck passenger car rear-end collisions. *Transportation Research Record: Journal of the Transportation Research Board*, 1635(1), 63-71.

El-Osta, H. S., Morehart, M. J., Johnson, J. D., and Hopkins, J. W. (2002). Income, wealth, and the economic well-being of farm households. Washington, DC: US Department of Agriculture, Economic Research Service.

FAO (Food and Agriculture Organization of the United Nations). (2010). State of Food Insecurity in the World 2010 - Addressing food insecurity in protracted crises. FAO, Rome, 2010.

FAO (Food and Agriculture Organization of the United Nations)/Nutrition and Consumer Protection Division. (2007). Guidelines for measuring household and individual dietary diversity. Rome, FAO.

FAO (Food and Agriculture Organization of the United Nations). (1996). Rome Declaration on Food Security and World Food Summit Plan of Action. Retrieved 26 October 2013.

FAOSTAT (Food and Agriculture Organization Statistical Databases). (2010).

FAOSTAT (Food and Agriculture Organization Statistical Databases). (2013).

Farley K., Lucas S. and Hogue E. (2012). Principles into Practice; Impact Evaluations of Agriculture Projects. Millennium Challenge Corporation, October 10, 2012.

Feder, G., Murgai, R., and Quizon, J. B. (2004). Sending farmers back to school: The impact of farmer field schools in Indonesia. *Applied Economic Perspectives and Policy*, *26*(1), 45-62.

Ferraro, P. J. (2009). Counterfactual thinking and impact evaluation in environmental policy. *New Directions for Evaluation*, *2009*(122), 75-84.

Filmer, D. (1999). The structure of social disparities in education: Gender and wealth. World Bank, Development Research Group, Poverty and Human Resources.

Filmer, D., and L. H. Pritchett. (2001). Estimating Wealth Effects without Expenditure Data—or Tears: An Application to Educational Enrolments in States of India. *Demography*, *38*(1), 115-132.

Filmer, D., and L. Pritchett. (1999). The effect of household wealth on educational attainment: evidence from 35 countries. *Population and development review*, 25(1), 85-120.

Freeman, H. A. and W. Kaguongo. (2003). Fertilizer Market Liberalization and Private Retail Trade in Kenya. *Food Policy*, 28(1), 505-518.

Gangopadhyay, S. and Wadhwa, W. (2004). Are Indian female-headed households more vulnerable to poverty. Bazaar Chintan.

George, D. and Mallery, P. (2003). SPSS for Windows step by step: A simple guide and reference. 11.0 update (4th edition). Boston: Allyn and Bacon.

Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B. and Vermeersch C. M. J. *Impact Evaluation in Practice*. (2011). The International Bank for Reconstruction and Development / The World Bank. 1818 H Street NW. Washington DC 20433. Pp. 3, 7, 107-110.

Glewwe, P., and H. G. Jacoby. (2004). Economic growth and the demand for education: is there a wealth effect? *Journal of Development Economics*, 74(1), 33-51.

Gliem, J. A. and Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., and Toulmin C. (2010). Food Security: The Challenge of Feeding 9 Billion People. Science 327, 812 (2010). DOI: 10.1126/science.1185383.

Greene, W. (2002). *Econometric analysis, Fifth edition*. Upper Saddle River, NJ: Prentice Hall. Pp. 736-740.

Grundy, E. (2006). Ageing and vulnerable elderly people: European perspectives. *Ageing and Society*, 26(1), 105-134.

Grune-Yanoff, T. (2010). *Rational Choice Theory and Bounded Rationality*. *In: Religion, Economy, and Evolution*. Pyysiäinen, I. (Ed.). Berlin: de Gruyter, Pp. 61-81.

Gujarati. 2004. Basic Econometrics, Fourth Edition. The McGraw−Hill Companies.

Haagenars, A., de Vos K. and Zaidi M. A. (1994). Poverty Statistics in the Late 1980s: Research Based on Micro-data. Office for Official Publications of the European Communities. Luxembourg.

Hahn, E. D., and Soyer, R. (2005). Probit and logit models: Differences in the multivariate realm. *Submitted to The Journal of the Royal Statistical Society, Series B*.

Headey, D., Malaiyandi, S. and Fan S. (2009). Navigating the Perfect Storm; Reflections on the Food, Energy, and Financial Crises. IFPRI Discussion Paper 00889. August 2009.

Heckman, J. (1997). Instrumental variables: A study of implicit behavioral assumptions used in making program evaluations. *Journal of Human Resources*, 441-462.

Heckman, J. J., Ichimura, H., and Todd, P. (1998). Matching as an econometric evaluation estimator. *The Review of Economic Studies*, 65(2), 261-294.

Henao J. and C. Baanante. (2006). Agricultural production and soil nutrient mining in Africa: Implication for resource conservation and policy development. IFDC Tech. Bull. International Fertilizer Development Center. Muscle Shoals, Al. USA.

Henao, J. and C. Baanante. (1999). Estimating Rates of Nutrient Depletion in Soils of Agricultural Lands of Africa. Technical Bulletin IFDC—T-48. May 1999. 500C

Hoddinot, J. and Y. Yohannes. (2002). Dietary Diversity as a Food Security Indicator. FCND Discussion Paper No. 136, Washington D.C.: IFPRI.

Hogarth, J., and Anguelov, C. (2004). Are families who use e-banking better financial managers? *Journal of Financial Counseling and Planning*, *15*(2), 61-77.

Holden, S. and R. Lunduka. (2010a). Too Poor to be Efficient? Impacts of the targeted fertilizer subsidy program in Malawi on farm plot level input use, crop choice and land productivity. Unpublished Manuscript, Department of Economics and Resource Management. Norwegian University of Life Sciences. Ås, Norway.

Holden, S., and Lunduka, R. (2010b). Impacts of the fertilizer subsidy program in Malawi: targeting, household perceptions and preferences. *Report to NORAD. Department of Economics and Resource Management, Norwegian University of Life Sciences*.

Imbens, G. (2004). Nonparametric Estimation of Average Treatment under Exogeneity: A Review. *The Review of Economics and Statistics*, 86(1), 4-29.

Imbens, G. W., and Lemieux, T. (2008). Regression discontinuity designs: A guide to practice. *Journal of Econometrics, 142*(2), 615-635.

Jayne, T. S., Govereh, J., Wanzala, M. and Demeke, M. (2003). Fertilizer market development: a comparative analysis of Ethiopia, Kenya, and Zambia. *Food Policy*, 28(4), 293-316.

Joshi G. and S. Pandey. (2005). Effects of Farmers' Perceptions on the Adoption of Modern Rice Varieties in Nepal. Conference on International Agricultural Research for Development. Deutscher Tropentag 2005 Stuttgart-Hohenheim, October 11-13, 2005.

Kelly, V., Crawford, E. and Ricker-Gilbert, J. (2011). The new generation of African fertilizer subsidies: panacea or Pandora's Box? Food Security Group Policy Synthesis Number 87. Department of Agricultural, Food and Resource Economics, Michigan State University.

Kenya County Fact Sheets. (2012).

Kristjanson, P., Okike, I., Tarawali, S., Singh, B. B. and Manyong, V. M. (2005). Farmers' perceptions of benefits and factors affecting the adoption of improved dual-purpose cowpea in the dry savannas of Nigeria. *Agricultural Economics,* 32(2), 195–210.

Lee, D. S., and Lemieux, T. (2009). *Regression discontinuity designs in economics* (No. w14723). National Bureau of Economic Research.

Ligon, E., and L. Schechter. (2003). Measuring Vulnerability. *The Economic Journal*, 113(486), 95-102.

Likert, R. (1932). A Technique for the Measurement of Attitudes. *Archives of Psychology*, 140, 1–55.

Liverpool-Tasie, L., and Sheu, S. (2013). Spill over effects of targeted subsidies: An assessment of fertilizer and improved seed use in Nigeria. IFPRI Discussion Paper 01260.

Livingston, G., Schonberger S. and Delaney S. (2011). Sub-Saharan Africa: The state of smallholders in agriculture. Conference on New Directions for Smallholder Agriculture. 24-25 January 2011, Rome, IFAD HQ.

Ludwig, J., and Miller, D. L. (2007). Does Head Start improve children's life chances? Evidence from a regression discontinuity design. *The Quarterly Journal of Economics*, *122*(1), 159-208.

Mathenge, M. K. (2009). Fertilizer Types, Availability and Consumption in Kenya. Tegemo Institute of Agricultural Policy and Development, Egerton University

McKelvey W. and T. Zavoina. (1975). A Statistical Model for Analysis of Ordinal Level Dependent Variables. *Journal of Mathematical Sociology*, 4(1), 103-120.

Mendola, M. (2007). Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh. *Food policy*, *32*(3), 372-393.

Minot, N. (2009). Smart fertilizer subsidies in sub-Saharan Africa: new wine or just new bottles? Panel on Smart Input Subsidies and Sustainable Development, Washington, DC, IFPRI.

Minot, N. and T. Benson. (2009*). Fertilizer subsidies in Africa: are vouchers the answer?* IFPRI Issue Brief 60. Washington, DC, IFPRI.

Mishra, A. K., and Goodwin, B. K. (1997). Farm income variability and the supply of off-farm labor. *American Journal of Agricultural Economics*, 79(3), 880-887.

MoA (Ministry of Agriculture). (2009). National Accelerated Agricultural Inputs Access Program (NAAIAP). Program Design and Guidelines. FY 2009/10

MoA (Ministry of Agriculture). (2010). National Accelerated Agricultural Inputs Access Program (NAAIAP). Program Design and Guidelines. FY 2010/11.

Morris, M., Kelly, V. A., Kopicki, R. and Byerlee, D. (2007). Promoting increased fertilizer use in Africa: lessons learned and good practice guidelines. Washington, DC, World Bank.

Mustafa-Msukwa, A. K., Mutimba, J. K., Masangano, C., and Edriss, A. K. (2011). An assessment of the adoption of compost manure by smallholder farmers in Balaka District, Malawi. *South African Journal of Agricultural Extension*, *39*(1), 17-25.

Newman, J., Pradhan, M., Rawlings, L. B., Ridder, G., Coa, R., and Evia, J. L. (2002). An impact evaluation of education, health, and water supply investments by the Bolivian Social Investment Fund. *The World Bank Economic Review*, *16*(2), 241-274.

Nigeria, C. (2010). Assessment of Farmers' Perception of the Effectiveness of Songhai-Delta Fish Culture Training Programme in Delta State, Nigeria. *Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension*, 9(2), 131-136.

Nyoro, J., Kirimi, L. and Jayne T. (2004). Competitiveness of Kenya and Ugandan Maize Production: Challenges for the Future. Tegemeo Working Paper No. 10. Nairobi: Tegemeo Institute of Agricultural Policy and Development: Egerton University.

OECD (Organization for Economic Cooperation and Development). (2009). *"What are equivalence scales?*" Retrieved 14th March 2013 from http://www.oecd.org/eco/growth/OECD-Note-EquivalenceScales.pdf

Petrick, M., and Zier, P. (2011). Regional employment impacts of Common Agricultural Policy measures in Eastern Germany: a difference-in-differences approach. *Agricultural Economics*, *42*(2), 183-193.

Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food Security*, 1(1), 5-7.

Ricker-Gilbert J. and T.S. Jayne. (2012). Do Fertilizer Subsidies Boost Staple Crop Production and Reduce Poverty across the Distribution of Smallholders in Africa? Quantile Regression Results from Malawi. Selected Paper prepared for presentation at the International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August, 2012.

Ricker-Gilbert, J. and T. S. Jayne. (2011). What are the Enduring Effects of Fertilizer Subsidy Programs on Recipient Farm Households? Evidence from Malawi. Staff Paper 2011-09; Department of Agricultural, Food and Resource Economics, Michigan State University.

Ricker-Gilbert, J., Jayne, T., and Shively, G. (2013). Addressing the "wicked problem" of input subsidy programs in Africa. *Applied Economic Perspectives and Policy*, *35*(2), 322-340.

Rosenbaum, P. and D. Rubin. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika*, 70(1), 41-55.

Ruel M. T. (2004). Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. FCND Discussion Paper No: 140. IFPRI.

Sheahan, M., Black, R. and Jayne T. S. (2012). Are Kenyan farmers under-utilizing fertilizer? Implications for input intensification strategies and research. Contributed paper presented at the International Conference of Agricultural Economists. Iguacu Falls, Brazil, August 20, 2012.

Shiferaw B. and S. T. Holden. (1998). Resource degradation and adoption of land conservation technologies in the Ethiopian Highlands: A case study in Andit Tid, North Shewa. *Agricultural Economics*, 18(3), 233-247.

Takeshima, H., Nkonya, E. M., and Deb, S. (2012). Impact of Fertilizer Subsidies on the Commercial Fertilizer Sector in Nigeria Evidence from Previous Fertilizer Subsidy Schemes. IFPRI Working Paper No. 23.

Taylor, R. (1990). Interpretation of the correlation coefficient: a basic review. *Journal of diagnostic medical sonography*, 6(1), 35-39.

United Nations (UN). (2000). United Nations Millennium Declaration. United Nations A/RES/55/2.

Van der Klaauw, W. (2002). Estimating the Effect of Financial Aid Offers on College Enrollment: A Regression–Discontinuity Approach*. *International Economic Review*, *43*(4), 1249-1287.

Varian H. R. (2010). *Intermediate Microeconomics: A Modern Approach*. 8th edition. New York: W.W. Norton and Company. 2010. Pp. 223-224.

Williams, R. (2009). Using heterogeneous choice models to compare logit and probit coefficients across groups. *Sociological Methods and Research*, 37(4), 531-559.

Winters, P. Salazar, L. and Maffioli A. (2010). Designing Impact Evaluations for Agricultural Projects Impact-Evaluation Guidelines. Inter-American Development Bank.2010.

Winters, P., Maffioli, A., and Salazar, L. (2011). Introduction to the special feature: Evaluating the impact of agricultural projects in developing countries. *Journal of Agricultural Economics, 62*(2), 393-402.

Wooldridge J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. The MIT Press Cambridge, Massachusetts London, England. Pp. 603-644.

World Resources Institute. (2013).

Yadav, S. B. M., Daipuria, O. P., and Chauhan, S. V. S. (2011) Impact of Training Programmes on Adoption of Organic Farming Practices. *Assessment*, *22*(50.83), 26-67.

Yamane, T. (1967). *Statistics: An Introductory Analysis*, 2nd Ed., New York: Harper and Row.

Yamano T. and A. Arai. (2010). Fertilizer Policies, Price, and Application in East Africa. GRIPS Discussion Paper 10-24. December 2010. National Graduate Institute for Policy Studies 7-22-1 Roppongi, Minato-ku, Tokyo, Japan 106-8677.

Yanggen, D., Kelly, V., Reardon, T. and Naseem A. (1998). Incentives for fertilizer use in Sub-Saharan Africa: Review of Empirical Evidence on Fertilizer Response and Profitability. International Development Working Paper No. 70, Michigan State University, East Lansing, Mich., U.S.A.

Zhao, Z. (2008). Sensitivity of propensity score methods to the specifications. *Economics Letters*, 98: 309-319.

APPENDICES

Appendix 1: QUESTIONNAIRE

Thank you for accepting to exercise in this study. The information gathered will only be used for academic purposes only and treated with utmost confidentiality. I appreciate your willingness to participate in this study.

Division……. **Location…….**

Enumerator…….. **Date…….**

1. HOUSEHOLD PROFILE

House hold member number **HMNUM**	First Name	Sex 1=Male 0=Female	Age	Relationship to head 1=head 2=spouse 3=Child 4= Parent 5= Niece 6= Nephew 7= Worker 8= Grand child 9=Brother/sis in-law 10=Bro./sis 11=Other	Size of farm (acre) 1= <1 2= 1-1.9 3= 2-3.9 4= 4 and above	Marital status 1=Single 2=Monogamous 3=Polygamous 4=Divorced 5=Windowed 6=Separated 7=Other	Education level **Level of education** 0= none 1= Incomplete Primary 2=Complete Primary 3=Incomplete Secondary 3= Complete secondary 4=Tertiary polytechnic 5=Tertiary college 6= University	Was this person involved in any I**ncome earning** activity in the past **12 months** ***1 = Yes*** ***2 = No (got to next member)***	If yes, Which **Income earning activities?** ***(See Activity Code below)***		Months involved in the activity in the last 12 months		Monthly income from activity (Kshs)	
									IGA1	**IGA2**	**IGA1**	**IGA2**	**IGA1**	**IGA2**
1(Head)														
2(Spouse)														
3														
4														
5														
6														
7														
8														
Income generating activities : 1=Formal employment 2= Informal employment (farm) 3= Informal employment (Non-farm) 4=Business														

2. INCOME ANDCAPACITY TRAINING

NO.	QUESTION	RESPONSE OPTION	CODE
1	Have you ever received any training on farming and input use?	1 = Yes, 2 = No	
2	Where did you get the training?	1 = NAAIAP, 2 = MoA officer, 3 = Group 4 = Institution, 5 = NGO, 6 = Well-wishers	
3	Which areas were you trained on?	1 = Fertilizer use, 2 = Maize husbandry 3 = Resource mobilization and utilization 4 = Post-harvest management, 5 = Cereal Banking 6 = Record keeping, 7 = Group formation and management 8 = Group formation and management 9 = Others (specify)…… ……	
	Was the training sufficient to help you produce maize in a profitable way?	1 = Yes 2 = No	
	If **NO**, in which areas would you require more training?	1 = Fertilizer use, 2 = Maize husbandry 3 = Resource mobilization and utilization 4 = Post-harvest management, 5 = Cereal Banking 6 = Record keeping, 7 = Group formation and management 8 = Group formation and management 9 = Others (specify)…… ……	
	Do you use inputs on yours farms?	1 = Yes, 2 = No	
	Which inputs do you use?	1 = Fertilizer, 2 = Certified seeds, 3 = Manure 4 = Others (specify)……. …….	
	Where do you get the inputs from?	1 = NAAIAP, 2 = Agro dealers, 3 = Own livestock 4 = Buys from neighbours, 5 = From relatives	
	What was your maize yield before use of inputs?(Bags/acre)	1 = 0-4, 2 = 5-9, 3 = 11-14, 4 = 15-19, 5 = 20-24, 6 = 25-29, 7 = 30 and above	
	What was the maize yield after using the farm inputs?(Bags/acre)	1 = 0-4, 2 = 5-9, 3 = 11-14, 4 = 15-19, 5 = 20-24, 6 = 25-29 7 = 30 and above	
	If production **increased**, how much was the	1 = 0-4, 2 = 5-9, 3 = 11-14, 4 = 15-19, 5 = 20-24, 6 = 25-29	

	surplus maize? (Bags)	7 = 30 and above	
	If production increased, what did you do with the surplus maize?	1=Preserved to feed the family, 2=Sold to get additional income 3=Sold and bought inputs (fertilizer/seed) 4= Sold and invested in another enterprise 5= Preserved in a cereal bank 6=other (specify)…….	
	If production **decreased,** what do you think was the reason?	1= Low rainfall, 2= Pests, 3= Poor management 4= Lack/Inadequate labour	
	What is the distance from your homestead to the **nearest agro dealer**?	1 = < 1km, 2 = 1- < 2km, 3 = 2- <4km 4 = 4km and above	
	What type of road connects your homestead to the **nearest agro dealer**?	1=murram /all weather, 2=tarmac, 3=dry weather 4=foot path**.**	
	What is the distance from your homestead to the **nearest agricultural extension service provider**?	1 = < 1km, 2 = 1- < 2km, 3 = 2- <4km 4 = 4km and above	
	What type of road connects your homestead to the **nearest agricultural extension service provider**?	1=murram /all weather, 2=tarmac, 3=dry weather 4=foot path**.**	
	Has the introduction of NAAIAP/*Kilimo Plus* made the distance to agro dealers shorter?	1 = Yes 2 = No	
	If yes, by how many kilometres?	1 = < 1km, 2 = 1- < 2km, 3 = 2- <4km, 4 = 4km and above	
	Has the introduction of NAAIAP/*Kilimo Plus* made the distance to extension services shorter?	1 = Yes 2 = No	
	If yes, by how many kilometres?	1 = < 1km, 2 = 1- < 2km, 3 = 2- <4km , 4 = 4km and above	
	At what amount would you like to buy fertilizer?	1 = < 10kg 2 = 10-19kg 3 = 20-29kg 4 = 30-39kg 5 = < 50kg 6 = >50kg	
	At the nearest retail outlet what is the largest		

	fertilizer package?	…… 1 = < 10kg, 2 = 10-19kg, 3 = 20-29kg, 4 = 30-39kg, 5 = < 50kg 6 = >50kg	
	At the nearest retail outlet What is the smallest fertilizer package?	…….. 1 = < 10kg, 2 = 10-19kg, 3 = 20-29kg, 4 = 30-39kg, 5 = < 50kg 6 = >50kg	
	Do you intend to use inputs in future?	1 = Yes, 2 = No	
	If No, why?	…… …… ……	
	If yes, what arrangements have you put in place for raising funds to invest in inputs?	1 = Cereal bank, 2 = Savings, 3 = Bank loan, 4 = Group loan 5= Other (specify) …… ……..	
	Where would you like to source your inputs from?	1 = NAAIAP, 2 = Agro dealer 3 = Government/NCPB	

Which of these items have you bought from farm income?

Item		Current number	*Unit value*	*Total current value*	Item		Current number	*Unit value*	*Total current value*
item		**cnum**	**Untval**	**totval**	**Item**		**cnum**	**Untval**	**totval**
Cow shed (s)	**1**				Farm house(s)	**18**			
Ox plough	**2**				Furniture	**19**			
Food store	**3**				Panga	**20**			
Water trough	**4**				Jembe	**21**			
Milking shed	**5**				Vehicle(s)	**22**			
Chuff cutter	**7**				Tractor trailer	**24**			
Wheel barrow	**8**				Water tank	**25**			
Sprayer pump	**9**				Posho mill	**26**			
Donkey/ox cart	**10**				Cereals Sieve	**27**			
Feed troughs	**11**				Well	**28**			
Milk Buckets	**12**				Power saw	**29**			
Bicycle	**13**				Mobile phone	**30**			
Television	**14**				Fixed land line	**31**			

	Radio	**15**				Irrigation equip.	**32**			
	Spade/shovel	**16**				Borehole	**33**			
	Solar Panel	**17**				generator	**34**			
	Other (Specify)					Other(Specify)				

3. PERCEPTION

NO.	QUESTION	RESPONSE OPTION	CODE
	Are you aware of a government program that gives inputs?	1 = Yes, 2 = No	
	Do you know its name or can you explain it?	…… …… ……	
	Are you aware of NAAIAP/*Kilimo Plus* program?	1 = Yes, 2 = No	
	Where did you learn of NAAIAP?	1 = Friend or neighbour, 2 = Group 3= Agricultural officer, 4 = Radio 5 = Newspaper, 6 = TV, 7=Chief baraza	
	Please answer the following questions in regards to the NAAIAP/*Kilimo Plus* program.	0 = poor, 1= fair, 2 = average, 3 = good 4 = excellent	
	The program has helped poor farmers to produce more.		
	The program has helped poor farmers to pay school fees much easily		
	The program has helped poor farmers to not go hungry.		
	The program has increased farmers income.		
	The program has increased the number of agro dealers in the area.		
	The program has reduced the distance I walk to access fertilizer and seeds.		
	The program has made agricultural officers available.		
	The program has enabled me to gain knowledge.		
	The program diversified sources of livelihood.		
	The program has enabled me to start saving money.		
	The program has enabled me to open an account. (ANY, bank, group or SACCO)		
	The program enabled me to join/form a farmer group with other beneficiaries.		
	The program is?		

4. Food Security

a. Diet Diversity

Please describe the foods (meals and snacks) that you ate yesterday during the day and night, whether at home or outside the home. Start with the first food eaten in the morning.

[Household level: consider foods eaten by any member of the household, and exclude foods purchased and eaten outside of the home]

No.	FOOD GROUP	EXAMPLES	YES=1 NO=0
1	CEREALS	bread, noodles, biscuits, cookies or any other foods made from millet, sorghum, maize, rice, wheat + *insert local foods e.g. ugali, nshima, porridge or pastes or other locally available grains*	
2	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrots, squash, or sweet potatoes that are orange inside + *other locally available vitamin-A rich vegetables(e.g. sweet pepper)*	
3	WHITE TUBERS AND ROOTS	White potatoes, white yams, cassava, or foods made from roots.	
4	DARK GREEN LEAFY VEGETABLES	dark green/leafy vegetables, including wild ones + *locally available vitamin-A rich leaves such as cassava leaves etc.*	
5	OTHER VEGETABLES	other vegetables, including wild vegetables	
6	VITAMIN A RICH FRUITS	ripe mangoes, papayas + *other locally available vitamin A rich fruits*	
7	OTHER FRUITS	other fruits, including wild fruits	
8	ORGAN MEAT (IRON RICH)	liver, kidney, heart or other organ meats or blood-based foods	
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds	
10	EGGS		
11	FISH	fresh or dried fish or shellfish	
12	LEGUMES, NUTS AND SEEDS	beans, peas, lentils, nuts, seeds or foods made from these	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	
14	OILS AND FATS	oil, fats or butter added to food or used for cooking	
15	SWEETS	sugar, honey, sweetened soda or sugary foods such as chocolates, sweets or candies	
16	SPICES, CONDIMENTS, BEVERAGES	spices(black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages OR *local examples*	

		YES=1 NO=0
Individual level only	Did you eat anything (meal or snack) OUTSIDE of the home yesterday?	
Household level only	Did you or anyone in your household eat anything (meal or snack) OUTSIDE of the home yesterday?	

Dietary Diversity questionnaire adopted FAO/Nutrition and Consumer Protection Division, version of May, 2007.

b. Food Insecurity Perception

NO.	QUESTION	RESPONSE OPTIONS	CODE
	What is your primary source of food for the household?	1 = Own production, 2 = Buying 3 = Borrowed, barter trade, labour exchange, gift from friends or relatives, 4 = Food aid	
1	Please answer the following statements referring to the last 12 months.	0 = Often true, 1 = Sometimes true, 2 = Never true 3 = Refused, 4 = Don't know	
	a. We have always had enough to eat and the kind of food we want.		
	b. We always have food to eat but not the right quality.		
	c. Sometimes we don't have enough food to eat.		
	d. Often don't have enough food to eat.		
	If response to 1 a, b or c is code 1 or 2, continue, if not skip to 6		
2	Please answer the following statements referring to the last 12 months.	0 = Often true, 1 = Sometimes true, 2 = Never true 3 = Refused, 4 = Don't know	
	a. We were worried that food would run out before we got money to buy more.		
	b. The food we bought just didn't last for long and we didn't have enough money to get more food.		
	c. We couldn't afford to eat balanced meals (carbohydrates, protein, vitamins)		
3	In the past 12 months, did you or any household member have to eat less food or skip a meal because of lack of enough money to buy food?	0 = Yes, 1 = No 3 = Refused 4 = Don't know	
3 a	How often did this happen?	0 = Every month, 1 = Some months but not every month, 2 = Only 1 or 2 months, 3 = Refused, 4 = Don't know	
	In the last 12 months did you ever eat less than you felt you should because there wasn't enough money for food?	0 = Yes, 1 = No, 3 = Refused, 4 = Don't know	
	In the last 12 months, were you ever hungry but you couldn't eat because there wasn't enough money for food?	0 = Yes, 1 = No, 3 = Refused 4 = Don't know	
4	In the last 12 months did you lose weight because there	0 = Yes,1 = No, 3 = Refused, 4 = Don't know	

	wasn't enough money for food?	**If yes continue, if otherwise skip to 6**	
5	In the last 12 months, did you or any adult of the household skipped food for a whole day because there wasn't enough money for food?	0 = Yes, 1 = No, 3 = Refused, 4 = Don't know **If yes continue, if otherwise skip to 9**	
5 a	How often did this happen?	0 = Every month, 1 = Some months but not every month, 2 = Only 1 or 2 months, 3 = Refused, 4 = Don't know	
If there is a child in the household ≤ 17 years continue, otherwise go to 7			
6	Please answer the following statements referring to the last 12 months.	0 = Often true, 1 = Sometimes true, 2 = Never true, 3 = Refused, 4 = Don't know	
	a. We relied on only a few kinds of low-cost foods to feed the child/children because there wasn't enough money for food.		
	b. We couldn't feed the child/children a balanced meal because there wasn't enough money for food.		
	c. The child/children were not eating enough because there wasn't enough money for food.		
	If response to 6 a, b or c is code 1 or 2, continue, if not skip to 9		
7	In the last 12 months, did you reduce quantity of child's/children's meals because there wasn't enough money for food?	0 = Yes, 1 = No 3 = Refused 4 = Don't know	
8	In the last 12 months, the child/children ever skip meals because there wasn't enough money for food.	0 = Yes, 1 = No, 3 = Refused, 4 = Don't know **If yes continue, if otherwise skip to 9**	
8 a	How often did this happen?	0 = Every month, 1 = Some months but not every month, 2 = Only 1 or 2 months, 3 = Refused, 4 = Don't know	
9	In the last 12 months, were the child/children ever hungry because there wasn't enough money for food?	0 = Yes, 1 = No, 3 = Refused, 4 = Don't know	
10	For the last 12 months, did the child/children ever not eat for a whole day because there wasn't enough money for food?	0 = Yes, 1 = No, 3 = Refused, 4 = Don't know	
11	For the last 12 months, did you ever reduce the quantity of child's/children's meals because there wasn't enough money for food?	0 = Yes, 1 = No 3 = Refused 4 = Don't know	
12	For the last 12 months, did any of your child/children skip meal(s) because there wasn't enough money for food?	0 = Yes, 1 = No 3 = Refused, 4 = Don't know	
	For the last 12 months, did you or household member get emergency food from a church of food aid organization?	0 = Yes, 1 = No, 3 = Refused 4 = Don't know	

Food Insecurity perception questionnaire adopted from USAID version 3, 2007

5. STAFFTRAINING

NO.	QUESTION	RESPONSE OPTION	CODE
1.	Have you ever received any training on NAAIAP?	1 = Yes 2 = No	
2.	Which areas were you trained on?	1 = Fertilizer use, 2 = Maize husbandry, 3 = Resource mobilization and utilization, 4 = Post-harvest management, 5 = Cereal Banking, 6 = Record keeping, 7 = Group formation and management 8 = Others (specify)…… ……	
	Which area have you found most relevant?	1 = Fertilizer use, 2 = Maize husbandry, 3 = Resource mobilization and utilization, 4 = Post-harvest management, 5 = Cereal Banking, 6 = Record keeping, 7 = Group formation and management 8 = Others (specify)…… ……	
	When was the last training attended?	…… ……	
	Were you given any resources to facilitate the program?	1 = Yes 2 = No	
	Which are the resources were you given?	…… …….. ……..	
	Which areas would you recommend for further training?	1 = Fertilizer use, 2 = Maize husbandry, 3 = Resource mobilization and utilization, 4 = Post-harvest management, 5 = Cereal Banking, 6 = Record keeping, 7 = Group formation and management 8 = Others (specify)…… ……	
	Do you think the training(s) you have received is sufficient to run NAAIAP in your area of jurisdiction?	1 = Yes 2 = No	

Appendix 2: Reliability Analysis

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	52	13.0
	Excluded[a]	348	87.0
	Total	400	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.871	.874	13

Item Statistics

	Mean	Std. Deviation	N
The program has helped poor farmers to produce more maize.	3.65	.837	52
The program has helped poor farmers to pay school fees much easily	3.60	.913	52
The program has helped poor farmers to not go hungry.	3.90	.823	52
The program has increased farmers income.	3.73	.744	52
The program has increased the number of agro dealers in the area.	3.65	1.186	52
The program has reduced the distance I walk to access fertilizer and seeds.	3.92	1.007	52
The program has made agricultural officers available.	4.15	.849	52
The program has enabled me to gain knowledge.	4.12	.943	52
The program diversified sources of livelihood.	3.67	1.004	52
The program has enabled me to start saving money.	3.58	1.091	52
The program has enabled me to open an account. (ANY, bank, group or SACCO)	3.62	1.087	52
The program enabled me to join/form a farmer group with other beneficiaries.	3.62	.932	52
The program is?	4.42	.723	52

Inter-Item Correlation Matrix

	The program has helped poor farmers to produce more maize.	The program has helped poor farmers to pay school fees much easily	The program has helped poor farmers to not go hungry.	The program has increased farmers income.	The program has increased the number of agro dealers in the area.	The program has reduced the distance I walk to access fertilizer and seeds.	The program has made agricultural officers available.	The program has enabled me to gain knowledge.	The program diversified sources of livelihood.	The program has enabled me to start saving money.	The program has enabled me to open an account. (ANY, bank, group or SACCO)	The program enabled me to join/form a farmer group with other beneficiaries.	The program is?
The program has helped poor farmers to produce more maize.	1.000	.557	.634	.445	.173	.340	.352	.275	.306	.266	.475	.354	.149
The program has helped poor farmers to pay school fees much easily	.557	1.000	.678	.558	.249	.371	.259	.420	.088	.298	.314	.436	.323
The program has helped poor farmers to not go hungry.	.634	.678	1.000	.662	.086	.251	.302	.293	.270	.325	.440	.283	.136

The program has increased farmers income.	.445	.558	.662	1.000	.003	.181	.191	.241	.352	.268	.306	.300	.289
The program has increased the number of agro dealers in the area.	.173	.249	.086	.003	1.000	.585	.229	.317	.479	.369	.457	.356	.425
The program has reduced the distance I walk to access fertilizer and seeds.	.340	.371	.251	.181	.585	1.000	.473	.216	.324	.238	.313	.344	.449
The program has made agricultural officers available.	.352	.259	.302	.191	.229	.473	1.000	.394	.244	.326	.533	.398	.275
The program has enabled me to gain knowledge.	.275	.420	.293	.241	.317	.216	.394	1.000	.331	.373	.274	.632	.445

The program diversified sources of livelihood.	.306	.088	.270	.352	.479	.324	.244	.331	1.000	.551	.493	.345	.329
The program has enabled me to start saving money.	.266	.298	.325	.268	.369	.238	.326	.373	.551	1.000	.422	.473	.306
The program has enabled me to open an account. (ANY, bank, group or SACCO)	.475	.314	.440	.306	.457	.313	.533	.274	.493	.422	1.000	.374	.136
The program enabled me to join/form a farmer group with other beneficiaries.	.354	.436	.283	.300	.356	.344	.398	.632	.345	.473	.374	1.000	.450
The program is?	.149	.323	.136	.289	.425	.449	.275	.445	.329	.306	.136	.450	1.000

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
The program has helped poor farmers to produce more maize.	45.98	51.706	.559	.519	.862
The program has helped poor farmers to pay school fees much easily	46.04	50.783	.578	.693	.860
The program has helped poor farmers to not go hungry.	45.73	51.887	.555	.682	.862
The program has increased farmers income.	45.90	53.422	.475	.601	.866
The program has increased the number of agro dealers in the area.	45.98	49.313	.505	.644	.866
The program has reduced the distance I walk to access fertilizer and seeds.	45.71	50.405	.540	.594	.862
The program has made agricultural officers available.	45.48	51.980	.526	.540	.863
The program has enabled me to gain knowledge.	45.52	50.882	.548	.539	.862
The program diversified sources of livelihood.	45.96	50.234	.555	.616	.862
The program has enabled me to start saving money.	46.06	49.350	.561	.453	.861
The program has enabled me to open an account. (ANY, bank, group or SACCO)	46.02	48.725	.608	.610	.858
The program enabled me to join/form a farmer group with other beneficiaries.	46.02	49.980	.629	.537	.857
The program is?	45.21	53.425	.491	.448	.865

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
49.63	59.138	7.690	13

Appendix 3: Multicollinearity Test

Variable Inflation Factor

Variable	VIF	1/VIF
FARMSIZE	1.08	0.922519
PRDNINC	1.05	0.949154
AGE	1.05	0.950861
NONFARMINC	1.04	0.958140
HOUSEHOLDSIZE	1.02	0.983830
FARMINC	1.01	0.993530
Mean VIF	1.04	

Variance-Covariance Estimator

Correlation matrix of coefficients of regress model

e(V)	RELHHS~E	RELHHC~D	RELHHP~T	RELHHN~E	RELHHB~W	INC~MARY	COM~MARY	INC~DARY	COM~DARY	TERTI~GE	TRAINING
RELHHSPOUSE	1.0000										
RELHHCHILD	0.2509	1.0000									
RELHHPARENT	0.2102	0.1189	1.0000								
RELHHNIECE	0.0510	0.0388	0.0590	1.0000							
RELHHBROSI~W	0.0742	0.0341	0.0495	0.0055	1.0000						
INCOMPL~MARY	-0.0612	-0.0135	-0.0949	-0.0080	-0.0101	1.0000					
COMPLETEPR~Y	-0.0013	-0.0168	-0.0312	-0.0512	-0.0067	0.6040	1.0000				
INCOMPL~DARY	0.0568	-0.0059	-0.0805	-0.0096	-0.0627	0.4836	0.5616	1.0000			
COMPLETESE~Y	0.0347	-0.0485	-0.0075	0.0003	-0.0388	0.5447	0.6255	0.5105	1.0000		
TERTIARYP~GE	0.0156	-0.0061	0.0174	-0.0008	0.0035	0.3198	0.3777	0.3013	0.3379	1.0000	
TRAINING	0.0810	0.0398	0.1018	0.0263	0.0613	0.0509	0.1608	0.0938	0.0472	0.0887	1.0000
LEARNSOURC~H	-0.0418	0.0209	-0.0712	-0.0136	-0.2410	0.0321	0.0545	-0.0158	-0.0328	0.0072	-0.1003
LEARNSOURC~P	-0.0742	-0.0349	-0.0818	-0.0129	-0.0282	0.0267	0.0133	0.0401	0.0680	0.0363	-0.2949
LEARNSOURC~F	0.0108	0.0411	-0.0033	-0.0100	-0.0126	0.0243	0.0557	0.0626	-0.0085	0.0380	-0.2206
LEARNSOURC~O	0.0177	-0.0659	-0.2188	-0.1726	-0.0131	0.0300	0.0427	0.0765	0.0100	0.0192	-0.0726
_cons	-0.3655	-0.1620	-0.0914	-0.0029	-0.0136	-0.6243	-0.7682	-0.6271	-0.6781	-0.4195	-0.2574

e(V)	LEARNS~H	LEARNS~P	LEARNS~F	LEARNS~O	_cons
LEARNSOURC~H	1.0000				
LEARNSOURC~P	0.0876	1.0000			
LEARNSOURC~F	0.0816	0.1006	1.0000		
LEARNSOURC~O	0.1065	0.0921	0.0720	1.0000	
_cons	-0.0996	-0.0421	-0.0818	-0.1316	1.0000

Appendix 4: Bootstrapping of Standard Errors

Bootstrap Statistics HDDS Average Treatment Effects on the Treated (Stratification Matching) Results

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
atts	1000	1.4056	-.0103	0.3762	0.6674 2.1437 (N)
					0.6130 2.0681 (P)
					0.6131 2.0681 (BC)
Number of observations	400				
Replications	1000				

Note: N = normal, P = percentile, BC = bias-corrected

Bootstrap Statistics Food Security Score Average Treatment Effects on the Treated (Stratification Matching) Results

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
atts	1000	6.8164	-0.0152	0.7583	5.3284 8.304356(N) 5.2600 8.2639(P) 5.2569 8.2393(BC)
Number of observations	400				
Replications	1000				

Note: N = normal, P = percentile, BC = bias-corrected

Bootstrap Statistics Income Average Treatment Effects on the Treated (Stratification Matching) Results

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
atts	2	403.5028	-41.5225	91.1910	-755.1886 1562.194 (N) 297.4985 426.4621 (P) 297.4985 426.4621 (BC)
Number of observations	400				
Replications	2				

ATT estimation of HDDS with the Kernel Matching Method (Bootstrapped standard errors)

Participants	**Non-participants**	**ATT**	**Std. Err.**	**T**
28	313	0.920	0.359	2.560

ATT estimation of the food security score with the Kernel Matching Method (Bootstrapped standard errors)

Participants	**Non-participants**	**ATT**	**Std. Err.**	**T**
28	313	6.928	0.643	10.777

ATT estimation of the adjusted income with the Kernel Matching Method (Bootstrapped standard errors)

Participants	**Non-participants**	**ATT**	**Std. Err.**	**T**
28	313	163.453	179.253	0.912